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Section 13

Advanced Inspection Techniques

Topic 13.1 Timber

13.1.1

Introduction

At the present time, most advanced inspection techniques are used to supplement visual inspections. Advanced inspection techniques give inspectors the ability to further evaluate defects found during a visual inspection. They can also be used to perform inspections on members that are not accessible. Advanced inspection techniques usually require a professionally trained technician to perform the testing and a professional that has expertise in interpreting the advanced inspection results.

There are two main classifications of advanced inspection techniques. The first is labeled nondestructive testing. This classification pertains to all advanced inspection techniques that do not impair the usefulness of the member being tested. Destructive testing, the second main classification, covers all advanced inspection techniques that affect or destroy the structural integrity of the member being tested.

This Topic describes the different types of nondestructive and destructive test methods for timber bridge members and the general procedures for each.

13.1.2

Nondestructive Testing Methods

Pol-Tek

Pol-Tek is a sonic testing device that is used to detect rot or other low density regions in timber poles. Starting about six inches below the ground line, probes are pressed on opposite sides of the timber member. A trigger trips a hammer that sends a sound wave down one probe, through the member, and up the other probe to a dial (see Figure 13.1.1).



Figure 13.1.1 Pol-Tek Sonic Testing Apparatus

This method eliminates the need for making holes in good members. Members testing positive for rot are then drilled or cored to determine the nature of the defect. A dial reading that is low, compared with that of a good member of similar diameter, indicates rot or another low density region that delayed the sound wave within the member. However, several readings should be taken on the member since the readings are nearly instantaneous, and the Pol-Tek should be checked frequently for proper calibration.

Used by trained personnel, Pol-Tek works well with Douglas fir and western red cedar. However, it does not work as well with southern pine members because of the high incidence of ring shakes.

Spectral Analysis

Spectral Analysis, sometimes called stress wave, uses sonic waves to produce stress waves in a timber member. The stress waves are then used to locate decay in timber members. The stress waves travel through the timber member and reflect off the timber surface, any flaws, or joints between adjacent members at the speed of sound. It is known that stress waves travel slower in decayed members than in sound members. If the members dimensions are known, the amount of time it takes for a stress wave to travel a certain distance can prove that defects are evident due to longer stress wave timings.

Stress waves are also used to determine the in-situ strength of timber members. Sound timber members transmit waves at higher velocity than decayed wood. The velocity of the stress wave can be calculated by obtaining time of flight readings over a set length. The velocity can be converted into a dynamic modulus of elasticity, which in turn, allows professionals to estimate the strength properties of

the wood.

Ultrasonic Testing

Ultrasonic testing consists of high frequency sound waves introduced by a sending transducer. Discontinuities in the specimen interrupt the sound wave and deflect it toward a receiving transducer. The magnitude of the return signal allows a measurement of the flaw size. The distance to the flaw can be estimated from the known properties of the sound wave and of the material being tested. Ultrasonic testing can be used to detect cracks, internal flaws, discontinuities, and surface damage (see Figure 13.1.2).



Figure 13.1.2 Ultrasonic Testing Equipment

In timber bridge members, ultrasonic testing can be used to determine the in-place strength of timber bridge members, both above and below water. The load carrying capacity of the member is correlated to the member's wave velocity normal to the grain and to its in-place unit weight.

Vibration

A newer type of nondestructive testing that can determine the condition of timber bridge members deals with the use of vibrations. This nondestructive testing method is based on the philosophy that all sound timber members vibrate at a certain frequency. While testing a timber member, if the member vibrates at a different frequency than the established theoretical frequency, the member may have defects present. Vibratory testing methods in timber members are basically used to determine the members modulus of elasticity. From this, other properties of the timber member can be established.

13.1.3

Other Testing Methods

Boring or Drilling

Boring is the most dependable and widely used method for detecting internal decay in timber. Boring permits direct examination of an actual sample from a

questionable member. An increment borer is used to extract wood cores for examination (see Figure 13.1.3).



Figure 13.1.3 Increment Borer

Drilling is performed using a rechargeable drill or a brace and bit. An abrupt decrease in drilling resistance indicates either rot or a void. However, wet wood and natural voids can falsely suggest rot. While samples are generally not attainable, observation of the wood particles removed during the drilling process can provide valuable information about the member. The depth of preservative penetration, if any, can be determined, and regions of discolored wood may indicate rot.

A newer drilling technique is the use of a decay detection device. It operates upon the principle that a drill moving through sound wood will encounter more resistance than a drill moving through decayed, and/or soft wood. It records the resistance, using a pen, paper and rotary drum arrangement, so that a permanent graphic record of the test is generated. Sound wood produces a series of near vertical markings on the record, however, when decayed wood is encountered, the resistance drops and the markings assume a more horizontal or diagonal pattern. By studying the resulting record, an experienced operator can determine if decay exists and, because the record is marked in millimeters (mm) of penetration, can estimate the approximate location and size of the decayed area.



Figure 13.1.4 Decay Detection Device

The use of increment cores for assessing the presence and damage due to bacterial and fungal decay requires special care. Cleaning of the increment borer is necessary after each core extraction to eliminate transfer of organisms; trichloroethane has been found to work well. Core samples that do not show visible signs of decay can be cultured to detect the presence of potential decay hazards. Many laboratories can provide this service. Core samples are more commonly used to detect the presence of internal decay pockets and to measure the depth of preservative penetration and retention.

All bore holes can provide an entrance for bacterial and fungal decay to gain access to the member. As such, the holes must be treated with a preservative and must be plugged.

Moisture Content

Moisture meters can be used to determine moisture content in a timber member. Moisture contents exceeding 20% indicate the condition of the wood is conducive to decay. As a sliding hammer drives two electrodes into the wood, a ruler emerging from the top of the hammer measures the depth. These electrodes can measure moisture content to a depth of about 2 1/2 inches. Because the high moisture content of decaying wood causes steeper than normal moisture gradients, the meter is useful for determining the extent of decay.

Probing

Probing consists of inserting a pointed tool, such as an ice pick, into the wood and comparing its resistance with that of sound wood. Lack of resistance or excessive softness to probe penetration may reveal the presence of decay.

Two forms of probing are a pick test and a shell-thickness indicator. A pick test consists of removing a small piece of wood with a pick or pocketknife. If the wood splinters, it is probably sound wood, and if it breaks abruptly, it is probably

decayed wood.

A shell-thickness indicator is a thin, metal, hooked rod used to determine the thickness of solid, but not necessarily sound, wood. The rod is inserted into a hole made by coring or drilling and is then pulled back with pressure against the side of the hole. The hook should attach to the edge of a rot pocket, making it possible to determine the depth of the rot and the solid wood.

Shigometer

The Shigometer measures electrical resistance to detect rot in timber members. It should be used in wood with a moisture content of at least 27%, a value indicative of decaying wood. A probe is used consisting of two twisted, insulated wires with the insulation removed near the tip. This probe is inserted to various depths into a hole 3/32 inch in diameter. If the electrical resistance changes as the probe goes deeper, this indicates rot or a defect.

While this device effectively detects rot, it can also produce misleading readings on sound timber. Consequently, drilling or coring should be done on suspect members. Like the Pol-Tek, the Shigometer should be recalibrated frequently.

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Topic 13.2 Concrete

13.2.1

Introduction

Visual inspections are the most common types of inspections when dealing with bridge members. These inspections don't require sophisticated, highly technical apparatus to perform the inspection, and therefore, are the most economical. For concrete bridge members, a visual inspection can only report on the surface conditions based partly on the opinion of the inspector. Due to this fact, advanced inspection techniques are sometimes required to evaluate the underlying condition of concrete members. This topic describes and explains the common types of nondestructive and destructive testing that is available to evaluate concrete members.

13.2.2

Nondestructive Testing

Acoustic Wave Sonic/Ultrasonic Velocity Measurements

A full evaluation of concrete decks can be accomplished with sonic ultrasonic acoustic wave velocity measurements. This method delineates areas of internal cracking (including delaminations) and deteriorated concrete, including the quantification of strength characteristics (elastic moduli values). A mobile automated data acquisition device with an impact energy source and multiple sensors is the principle part of a computer-based monitoring and recording system for detailed evaluation of bridge decks. Bridge abutments and concrete support members are tested using the same recording system with a portable, hand-held sensor array (see Figure 13.2.1 and 13.2.2). The system works directly on either bare concrete or through wearing surfaces such as asphalt. It can distinguish between debonded asphalt and delaminations, and it is effective for a detailed evaluation of large areas.



Figure 13.2.1 Portable Hand Held Sonic/Ultrasonic Testing Sensor Array System (<http://www.ndtcorporation.com>)



Figure 13.2.2 Acoustic Emission Sensors

Delamination Detection Machinery

Delamination detection machinery is based on sonic responses and can be used to inspect concrete decks (see Figure 13.2.3). The portable electronic instrument consists of three components: a tapping device, a sonic receiver, and a signal interpreter. The instrument is moved across the deck as acoustic signals are passed through the deck. These signals are then received and electronically interpreted, and the output is used to generate a plan of the deck showing delaminated areas. This method can be used on asphalt covered surfaces, although accuracy decreases.



Figure 13.2.3 Delamination Detection Machinery

Electrical Methods

Half Cell Potentials are used to evaluate the corrosion activity of reinforcing steel embedded in concrete. Commonly known as CSE (Copper Sulfate Electrode) tests, reinforcing bar networks are physically accessed and wired for current detection. Half cell electrical potentials of reinforcing steel are measured by moving the CSE about the concrete surface. As the CSE contacts concrete over an actively corroding rebar, voltage is registered. Measured potential values reflect levels of corrosion activity in the rebar. Higher potential measurements indicate corrosion activity. This kind of survey can be used to determine core sample locations.

Electromagnetic Methods

Advancements in ground penetrating radar have lead to the development of the High Speed Electromagnetic Roadway Measurement and Evaluation System (HERMES) Bridge Inspector. This system was built by the Lawrence Livermore National Library to detect delaminations in concrete decks caused by reinforcement corrosion. The HERMES Bridge Inspector sends high frequency electromagnetic pulses from 64 radar antennas into a bridge deck while travelling over the structure. The device is setup in a trailer mounted towing vehicle and is made up of a computer workstation, storage device, survey wheel, control electronics, and the 64 antenna modules or transceivers (see Figure 13.2.3). The system can inspect up to a 1.9 m (6'-3") width at a time with maximum speeds of

up to 60 mph. At speeds of around 20 mph, the system can sample the concrete deck every 1.5 cm (9/16") in the direction of travel. Output information can be reconstructed to show cross-sections of the deck being inspected. The depth of penetration depends on time and the material type. A 30 cm (11-13/16") penetration in concrete can be accomplished in about 6 nanoseconds. In the near future, a new system, called HERMES II, will update the original HERMES Bridge Inspector based on experience gained from the original.



Figure 13.2.4 The HERMES Bridge Inspector

Pulse Velocity

Pulse Velocity techniques are used to evaluate relative quality of concrete and estimate compressive strength. The pulses pass through the concrete and the transit time is then measured. The pulse velocity is then interpreted to evaluate the quality of the concrete and to estimate in-place concrete compressive strength.

This equipment analyzes concrete in decks by measuring velocity of sound waves. Some equipment generates sound waves by shooting BB's onto the deck. The time for the waves to return depends on the integrity of the concrete.

Flat Jack Testing

The flat jack method was originally developed to test the in situ stress and deformation of rock and is now being applied to masonry structures. A portion of the horizontal mortar joint is removed, and the flat jack (an envelope made of metal) is inserted and pressurized to determine the state of stress. For deformation testing, two flat jacks are inserted, one directly above the other and separated by five or six courses.

Ground-Penetrating Radar

Ground-penetrating radar is used to detect deterioration of bridge decks. This technique uses low-power, high-frequency pulsed radar. An important benefit of this method is the ability to measure the thickness of asphalt covering. It can also be used to examine the condition of the top flange of box beams that may otherwise be inaccessible.

Impact-Echo Testing

The impact-echo technique has proven to be successful in detecting flaws in slabs and pavements and is now being applied to assess the condition of concrete beams and columns. Testing involves introducing a stress pulse into the concrete by mechanical impact. The pulse in the concrete is reflected by cracks, voids, and the boundaries of the structure. A transducer placed near the impact point monitors surface displacements caused by the reflections. The response can then be interpreted to detect flaws within the concrete (see Figure 13.2.4).

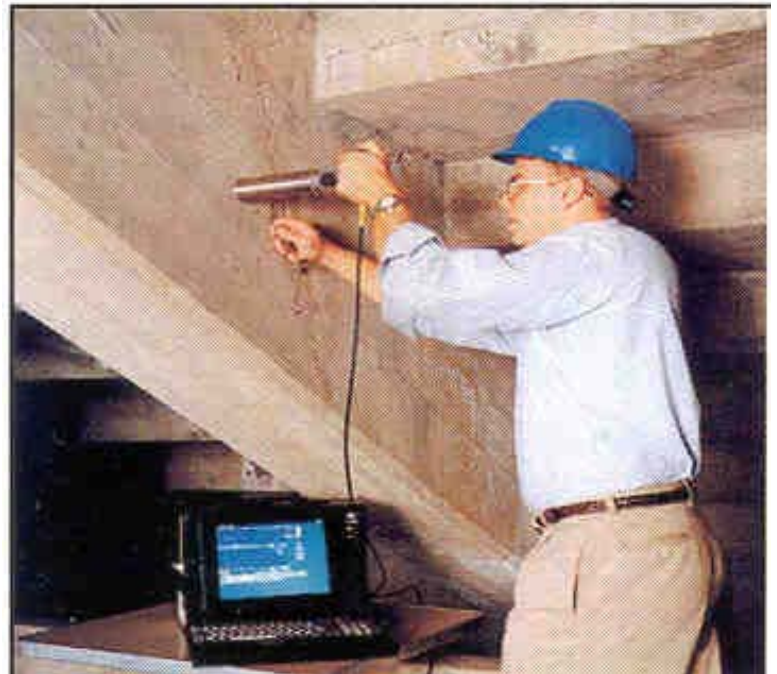


Figure 13.2.5 Impact-Echo Testing Equipment

Infrared Thermography

Infrared thermography is also used to detect deterioration of bridge decks. This technique uses an infrared camera to detect temperature differentials in a concrete surface. A "cold spot" indicates a delamination. Although subject to weather conditions, this technique is efficient for large surfaces.



Figure 13.2.6 Infrared Thermography Testing Equipment

Laser Ultrasonic Testing Laser ultrasonic testing provides information about flaws in concrete and about the position of steel reinforcement bars, which cannot be obtained with the non-laser ultrasonic testing described in this Section. Laser-generated acoustic wave measurements with high stress amplitudes provide information about the quality of the concrete at various depths from the surface. Reinforcing steel does not cause misleading results in laser ultrasonic testing as it does in non-laser ultrasonic testing.

Magnetic Field Disturbance

Advanced inspection techniques have been developed that can evaluate fatigue damage to steel reinforcement in concrete members. The device is known as the magnetic field disturbance (MFD) system and can be used on reinforced and prestressed concrete. The system maps the magnetic field across the bottom and sides of the beam. A discontinuity in magnetized steel, such as a fracture in a rebar or a broken wire in a steel strand, produces a unique magnetic signal. While the research has been encouraging for detecting fatigue-related damage due to the significantly different magnetic signals for corroded reinforcing, MFD has not yet been demonstrated for detecting in-service corrosion damage.

Neutron Probe for Detection of Chlorides

A neutron probe can be used to detect chlorides in construction materials. The materials are bombarded with neutrons from a small portable source. Measuring the gamma rays bouncing back provides a spectrum showing different elements, one of which is chloride. A major potential application that remains to be tested is measuring chlorides in reinforced concrete to determine corrosion hazard. Another potential application includes inspecting suspension bridge cables.

Nuclear Methods

The primary use of nuclear methods is to measure the moisture content in concrete by neutron absorption and scattering techniques. These moisture measurements are then used to determine if corrosion of reinforcement is likely to occur. A more direct measurement of the rate of corrosion would be more useful to the bridge inspector, and this method is therefore more research oriented than operational

Pachometer

A pachometer is a magnetic device used in determining the position of reinforcement. Magnetic methods do not detect concrete defects or deterioration directly. However, they can detect regions of inadequate cover, which is often associated with corrosion-induced deterioration. Magnetic methods can be used to measure cover in the range of 0 to 3 inches to an accuracy of about 1/4 inch

Rebound and Penetration Methods

Rebound and penetration methods measure the hardness of concrete and can be used to predict the strength of concrete. The Schmidt hammer (also known as the Swiss hammer) is probably the most commonly used device to measure the penetration resistance of hardened concrete. A spring-loaded device strikes the surface of the concrete, and based on the response, the compressive strength of the concrete can be determined. This inspection technique can be used to compare the quality of the concrete in different parts of concrete bridge components. However, only the surface of the concrete is being tested, and the strength value is relative.

Another common penetration device is called the Windsor probe. A pistol-like driving device fires a probe into the surface of the concrete. The probe is specifically designed to crack aggregate particles and to compress the concrete being tested.

Both of these tests are considered practical primarily with concrete that is less than one year old. However, when used in conjunction with core sampling, these tests can also be used to determine significant differences in concrete strength of older bridges.

Ultrasonic Testing

Ultrasonic testing can provide valuable information regarding the condition of concrete bridge members. However, the method can be difficult to use with reinforced concrete members, and some skill is required to obtain usable results.

Large cracks and voids can be detected, since the path of the pulse will travel around any cavity in the concrete and time of transmission is therefore lengthened. The presence of steel parallel to the line of transmission provides a path along which the pulse can travel more rapidly, causing misleading results. Therefore, it is generally desirable to choose paths that avoid the influence of reinforcing steel. Refer to Topic 13.1 for further details about the principles of ultrasonic testing.

13.2.3

Other Testing

Core sampling is a destructive form of concrete inspection, and it can weaken a member. Cores can be used for many of the following destructive tests. Usable cores can normally be obtained only if the concrete is relatively sound. If possible, cores should have a diameter three times the maximum aggregate size. All core holes should be filled with non-shrink concrete grout.

Carbonation

Carbonation of concrete is the result of the reaction of carbon dioxide and other acidic gases in the air, and it can cause a loss of protection of the reinforcing steel against corrosion. The depth of carbonation in a concrete bridge member can be measured by exposing concrete samples to a solution. Uncarbonated concrete areas change color, while carbonated concrete areas remain colorless.

Concrete Permeability

Air and water permeability can be measured by drilling a small hole into the concrete, sealing the top with liquid rubber, and inserting a hypodermic needle. Air permeability can then be determined by filling the hole with water and measuring the flow into the concrete at a pressure similar to that of rainfall. This method is seldom used in bridge inspections.

Concrete Strength

Actual concrete strength and quality can be determined only by removing a concrete core and performing such laboratory tests as:

- Compressive strength
- Cement content
- Air voids
- Static modulus of elasticity
- Dynamic modulus of elasticity
- Splitting tensile strength

Endoscopes and Videoscopes

Endoscopes and videoscopes are viewing tubes that can be inserted into holes drilled into a concrete bridge member (see Figure 13.2.7). Light can be provided by glass fibers from an external source. Some applications of this method include the inspection of the inside of a box girder and the inspection of hollow posttensioning ducts. Although this is a viewing method, it is considered to be a destructive method because some destruction is necessary for its proper use in concrete.



Figure 13.2.7 Remote Video Inspection Device

Moisture Content

Moisture content in concrete serves as an indicator of corrosion activity. Moisture content can be determined using nuclear methods (refer to Topic 13.2.2) or from concrete samples taken from the bridge and oven dried in a laboratory

Petrographic Examination

Laboratory technique for determining various characteristics of hardened concrete, which are useful in determining the existing condition and predicting future performance. Will detect Alkali-Silica Reaction (ASR) products.

Reinforcing Steel Strength

The actual properties of reinforcing steel can only be determined by removing test samples. Such removal of reinforcing steel can be detrimental to the capacity of the bridge and should be done only when such data is essential.

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Topic 13.3 Steel

13.3.1

Introduction

During a visual inspection of steel bridge members, the bridge inspector may come across a crack or area that can only be evaluated with the aid of advanced inspection techniques. Professional technicians typically perform these advanced inspection techniques, but bridge inspectors should have an understanding of the various options available. Many of the advanced inspection techniques used for steel can also be used for other materials. This Topic describes and explains the common types of nondestructive and destructive testing that is available for steel bridge members.

13.3.2

Nondestructive Testing

Acoustic Emissions Testing (American Society of Nondestructive Testing Designation (ASNT) - AE)

Acoustic emissions can be used to identify growing cracks. When cracks grow, they emit minute "sounds" which propagate outward from the source. Sensors placed on the surface of the member "listen" for these sounds. The bridge must be loaded so as to produce stress and cracking in the members when this test is used.

A device known as Local Area Monitoring (LAM) can be used to monitor areas that already are cracked or cracked areas that have been retrofit. The device is a portable, modular eight-channel system that can be mounted close to the area being monitored (see Figure 13.3.1). The system can be directly connected to a computer or it can be accessed through wired or wireless modems for data collection.



Figure 13.3.1 LAM System Showing Eight Sensors and Holding Magnet

| | |
|--|---|
| Computer Programs | Computer programs have been developed to maximize the value of bridge inspections. In the pre-inspection routine, the inspector enters data on the bridge design and previously detected flaws. The computer responds with a customized checklist for the inspector, flagging critical areas of the structure. In the post-inspection routine, the inspector enters data about the flaws encountered in the field, and the computer responds with information about if the crack is likely to propagate and how to repair the crack. This procedure allows the inspector to detect flaws early and to judge which ones need immediate repair. |
| Computer Tomography | Computer tomography uses X-ray and gamma radiation to visualize the interior defects of a steel member. The image is captured by a detector array, it is processed by a computer, and it is then reconstructed. This method is similar in many ways to medical CAT scans, and it has great potential for locating discontinuities of all types in steel members (as well as concrete members). |
| Corrosion Sensors | Corrosion sensors are being developed that use environmental variables such as dirt and duration of wetness to indicate the degree of corrosion of a steel structure. |
| Dye Penetrant (ASNT Designation - PT) | <p>A dye penetrant can be used to define the extent and size of surface flaws in steel members (see Figure 13.3.2). The test area is cleaned to bare metal, a dye is applied and allowed to penetrate the surface, and excess penetrant is removed. A developer is then applied, which draws the dye out of the irregularities and defines the extent and size of surface flaws. Bridge inspectors commonly use this method since it does not require extensive training or expensive equipment. A limitation of this method, however, is that it reveals neither the depth of cracks nor any subsurface flaws. Another important factor when performing dye penetrant testing is the penetrant dwell time. This is the amount of time that the penetrant is allowed to remain on the surface before the excess is wiped off. Factors that effect the dwell time include:</p> <ul style="list-style-type: none">➤ Temperature of the member being tested and the penetrant➤ Ambient air temperature (higher temperatures require shorter dwell times)➤ Humidity (low humidity causes penetrant to dry out rapidly)➤ Size and shape of the discontinuity (hairline cracks need more time than large ones)➤ Material type➤ Penetrant removal type and manufacturer's recommendations |

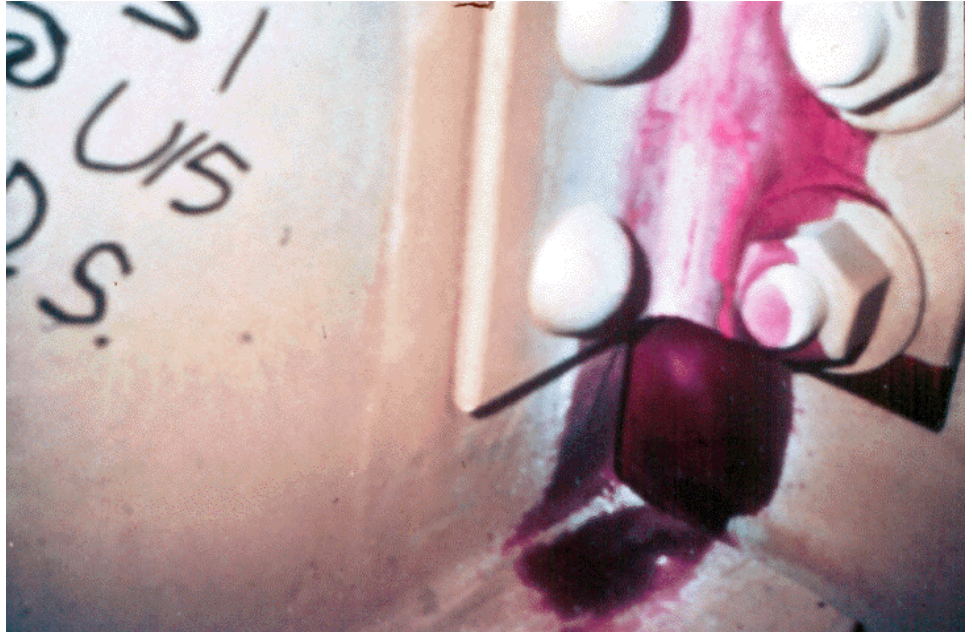


Figure 13.3.2 Detection of a Crack Using Dye Penetrant

Magnetic Particle (ASNT Designation - MT)

Magnetic particle or magnetic flux leakage is useful in detecting surface gouges, cracks, and holes in ferromagnetic materials. It can also detect subsurface defects, such as voids, inclusions, and cracks, which lie near the surface. A magnetic field is induced into the member, and cracks or other irregularities in the surface of the member cause irregularities in the magnetic field (see Figure 13.3.3). This technique is also referred to as magnetic field disturbance.

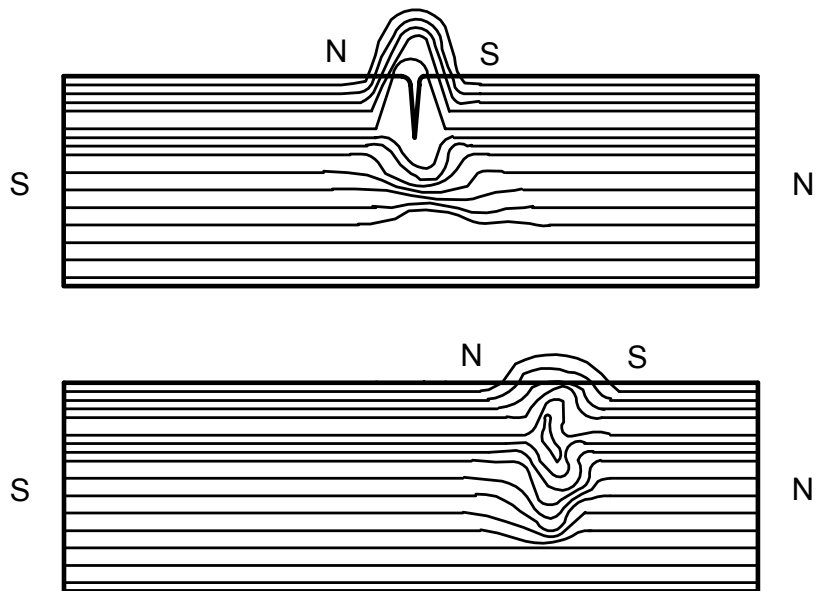


Figure 13.3.3 Schematic of Magnetic Field Disturbance

**Radiographic Testing
(ASNT Designation - RT)**

Radiographic testing is used to detect and locate surface and subsurface cracks, voids, and inclusions. X-rays or gamma rays are passed through the member and are absorbed differently by the various flaws. When a piece of film is exposed to the rays, the defects appear as shadows on the film. This type of advanced inspection is typically used for full penetration groove welds during fabrication and construction.

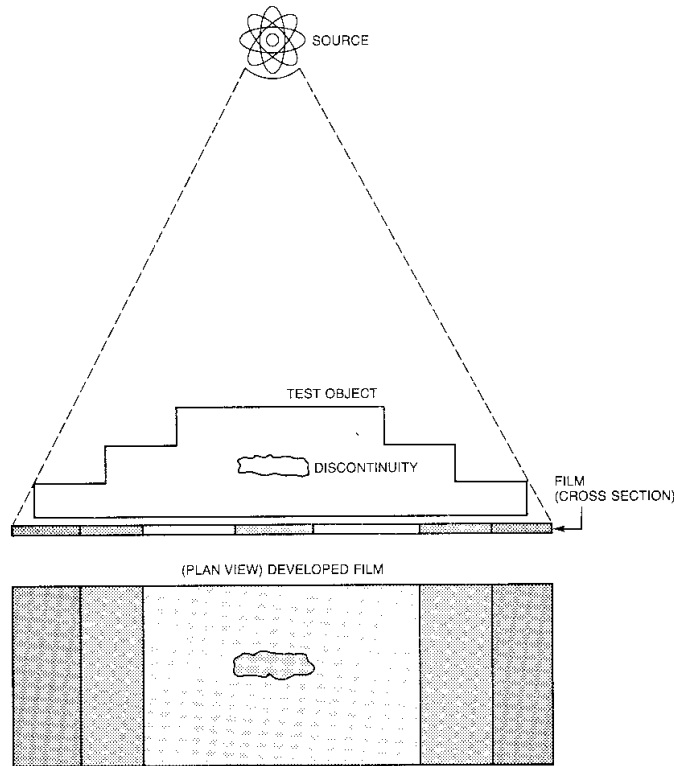


Figure 13.3.4 Radiographic Testing

Robotic Inspection

Several companies are currently developing and marketing a system which uses high-resolution video cameras on robotic arms attached to permanent falsework underneath the bridge. By remote telescanning, details can be visually monitored, with magnification if needed, without the inspector having to climb to gain access to a detail each time an inspection is desired. While the primary material application for robotic inspection is steel, it can also be used on timber and concrete bridges.

In recent years, the California Department of Transportation (Caltrans) has been working on an aerial robotic inspection system (see Figure 13.3.5). This system, in the testing and development stage, can allow bridge inspectors to view elevated bridge members from the ground. It is controlled by a remote control that is connected to the system through a 100 ft (30 m) electrical cord. A fiber optics cable transfers information and images from the aerial device to the ground station. This type of inspection may reduce traffic delays and increase the level of safety for motorists and bridge inspectors.



Figure 13.3.5 Robotic Inspection

Ultrasonic Testing (ASNT Designation - UT) Ultrasonic testing is frequently used in steel applications and can be used to detect cracks in flat, relatively smooth members, as well as pins (see Figure 13.3.6). It can also be used to measure the thickness of steel members, providing detailed information concerning loss of cross section. Ultrasonic testing also has many applications in the inspection of welds, detecting porosity, voids, inclusions, corrosion, cracks, and other discontinuities. Refer to Topic 13.1 for further details about the principles of ultrasonic testing.



Figure 13.3.6 Ultrasonic Testing of a Pin in a Moveable Bridge

**Eddy Current (ASNT
Designation - ET)**

This type of electromagnetic technique uses AC currents. Eddy current testing can only be performed on conductive materials and is capable of detecting cracks and flaws as well as member dimensions and variations. The system works by monitoring the voltage across a coil that has an AC current flowing through it. When the coil is placed next to the conductive member, the member produces eddy currents that flow opposite to the direction of flow from the coils. Defects in the member disturb the eddy currents, which, in turn, effect the induced current. The effected induced current is monitored through the voltage across the coil. Eddy current testing devices can be hand held devices (see Figure 13.3.7).



Figure 13.3.7 Hand Held Eddy Current Instrument

Information concerning non-destructive testing can be found on the American Society of Non-destructive Testing website: www.asnt.org.

13.3.3

Other Testing

Strength tests are normally considered destructive tests since they usually involve tests conducted on pieces of steel removed from the bridge. Small steel pieces cut out of steel members are called test "coupons." The removal technique and coupon size must be suitable for the planned tests. If a coupon is required, consult the bridge engineer to determine the most suitable area of removal. For instance, an inspector should not remove a coupon from the web area over a bearing. An inspector also should not remove a coupon from the bottom flange at midspan. Destructive tests may be necessary to determine the strength or other properties of existing iron or steel on bridges for which the steel type is unknown.

The following tests can be conducted only by the destructive technique of removing a sample and evaluating it in a laboratory.

Brinell Hardness Test

The Brinell hardness test measures the resistance to penetration of the steel. A hardened steel ball is pressed into the test coupon by a machine-applied load. The applied load and the surface area of the indentation are used to calculate the hardness of the steel. For a steel that has not been hardened by cold work, its hardness is directly related to its ultimate tensile strength.

Charpy Impact Test

An impact test determines the amount of energy required to fracture a specimen. A common impact test for steel coupons is the Charpy V-notch test (see Figure 13.3.8). A notched test coupon is placed in a vise, and a hammer is then released from an elevated position, swinging down and hitting the coupon. Since the force of the hammer is concentrated in a notch in the coupon, the stress goes into fracturing the specimen and not into strain. The energy required for fracture is determined based on the mass of the hammer and the distance that it fell. This test can be performed at different temperatures to determine if the steel is susceptible to brittle failure.

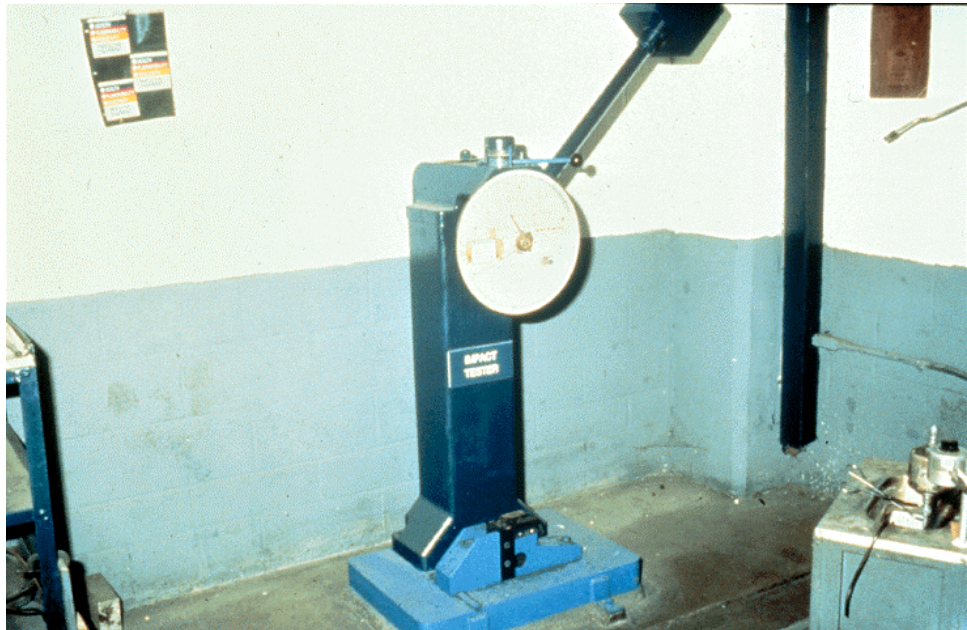


Figure 13.3.8 Charpy V-Notch Test

Chemical Analysis

The chemical composition of the steel is an important indication of whether a weld will crack, either from cold cracking or hot cracking. Tests can be performed on coupons to determine the chemical composition of the steel.

Cold, or delayed, cracking can be approximated using a carbon equivalent (C.E.) equation that is based on the chemical composition of the steel. One such equation, based on the relative proportions of various elements in the steel, is presented in the ASTM A706 rebar specification:

$$\text{C. E.} = \text{C}\% + \frac{\text{Mn}\%}{6} + \frac{\text{Cu}\%}{40} + \frac{\text{Ni}\%}{20} + \frac{\text{Cr}\%}{10} - \frac{\text{Mo}\%}{50} - \frac{\text{V}\%}{10}$$

When the C.E. is below 0.55, the steel is generally not susceptible to cold cracking, and no special precautions are required for welding. However, when the C.E. is above 0.55, the steel is susceptible to cold cracking, and special precautions are required for welding.

Hot cracking occurs as the weld begins to solidify. Hot cracks have almost been eliminated today due to modern welding material formulation.

Tensile Strength Test

The tensile strength is the highest stress that can be applied to the coupon before it ruptures. Once the yield strength has been exceeded, the coupon begins to elongate or "neck down" and eventually breaks if the load is not removed. The tensile strength of the steel can be easily determined. See Section P.1, Bridge Mechanics.

The ends of the test coupon are placed in vises on a testing machine. The machine then applies a tensile load to the ends of the coupon. The machine measures the load at which the coupon fails or ruptures. This load and the cross-sectional area of the coupon determine the tensile strength of the steel (See Figures 13.3.9 and 13.3.10).



Figure 13.3.9 Brittle Failure of Cast Iron Specimen



Figure 13.3.10 Ductile Failure of Cold Rolled Steel

13.3.4

Instrumentation

Detection and Warning of Bridge Collapse Sophisticated sensing devices and electronic equipment can be used to warn motorists of an imminent bridge collapse. Such warning equipment includes radar monitoring, accelerometers attached to the bridge, frequency transmitters and receivers, and a mechanical springboard device.

Laser Beam Line-of-Sight Detectors When structures suffer fractures or cracks, the weak point sags more than allowed in the design. A laser beam can be directed towards a sensor strategically placed on the structure. As the weak point sags, the sensor moves. When this displacement is greater than the level of tolerance, an alarm is activated. A computer can record the magnitude and rate of change of the deformation. This method can be used to detect potential structural failures.

Strain Gauges Strain gauges can be used to monitor the response of a member to a known live load. Foil mounted gauges can be used in the axial direction of flat members, and single wire filament, paper mounted gauges can be used on cables. Portable strain reading instruments can be used to monitor all gauges from a central location on or near the bridge.

Locations for strain gauges should be selected based on the condition of individual members, accessibility, and the objectives of the load-testing program. Well-designed strain gauge instrumentation can provide valuable information about:

- The actual transverse load distribution through the deck system
- The load sharing between elements of a multi-element member
- The effectiveness of the various members of the primary structural system

➤ The influence of deteriorated or defective members

Strain gauge instrumentation data has been interpreted to provide the weights of the vehicles crossing the bridge. This is known as a weighing-in-motion system.

System Identification

In recent years, an increasing number of bridges have been evaluated using measured response data. These have provided useful information and, in some instances, have revealed bridges which needed to be closed or restricted.

Using structural response data, the properties of the structure (e.g., areas and moments of inertia of structural members) can be calculated. The process of determining a structural model from response data is called system identification. The primary use of system identification in structural engineering has been for earthquake engineering research. The accuracy achieved indicates that system identification can also provide a valuable tool for detecting structural flaws.

System identification can be performed using a variety of response data, such as modal and time history response. For modal response, the frequencies and mode shapes of the structure are obtained either from ambient vibration data or from the results of harmonic excitation. A time history response is the response (i.e., displacements or acceleration) of one or more points on the structure as a function of time due to a known loading function. For either type of response data, the results are used to determine structural parameters representing the structural integrity of the bridge.

Initially, system identification is used to create a structural model, which more accurately represents the structure than a model used for design. Subsequent analyses are then performed to determine which parameters are changing. Since the parameters represent structural properties (e.g., areas and moments of inertia), the changes are indicative of structural deterioration.

Since bridge inspections focus on individual members, and system identification considers the entire structure, they are complementary processes. Therefore, system identification can be used to more accurately define the structural integrity of bridges. Using ambient vibrations to perform system identification creates the possibility of continuously monitoring bridges, even from a remote location.

Three-Dimensional Displacements and Strains

Current strain measurements are limited to point-determination or two-dimensional geometries. Research is being conducted to develop optical techniques to measure displacements and strains in three dimensions. The three-dimensional measurements will give a more accurate description of the interaction of bridge elements. The current testing involves global bridge measurement using coherent laser radar (CLR) and global bridge monitoring with wireless transponders. The global measurement using coherent laser radar system was adapted from a rapid inspection system developed for NASA. CLR is portable and can measure bridge deflection with sub-millimeter precision and is available commercially. The global bridge monitoring with wireless transponders system has many transponder/sensor modules that are battery powered. Once installed at a bridge site, these modules transfer information to a local controller using spread spectrum radio. The different types of modules available can measure strain, rotation, or displacement.

New technology is making the use of these highly technical systems economically feasible for bridge inspection. From this fact, advanced inspection techniques are becoming more popular for the routine inspection of all bridge members. Current and future studies have been, and will be focusing directly on relating results from advanced inspection techniques into Bridge Management Systems ratings.

Appendix

**PORT AUTHORITY OF ALLEGHENY COUNTY
PITTSBURGH, PENNSYLVANIA**

**REPORT ON THE
INITIAL NBIS INSPECTION
OF
CHARTIERS CREEK BRIDGE**

BMS No. 02 7421 0000 9061

Submitted By:

Michael Baker Jr., Inc.
Airport Office Park, Building 3
Coraopolis, Pennsylvania
15108

September, 2000

STRUCTURE B.M.S. NUMBER: 02 7421 0000 9061

BRIDGE NAME: Chartiers Creek Bridge

LOCATION: Crafton, Pennsylvania

INSPECTION DATE: June 23, 2000

INSPECTED BY: Michael Baker Jr., Inc.
Patrick A. Leach, P.E.
Charles L. Molnar

PREPARED FOR: Port Authority of Allegheny County

PREPARED BY: Michael Baker Jr., Inc.
Written By: Joseph E. Salvadori, E.I.T.
Reviewed By: Raymond A. Hartle, P.E.

**PORT AUTHORITY
AGREEMENT NUMBER:** 92-08

OWNER OF BRIDGE: Port Authority of Allegheny County

COST INFORMATION:

| | |
|---------------------|------------|
| Inspection & Report | \$3,108.00 |
| Rigging | \$1,560.00 |
| Traffic Control | \$ 0 |
| Railroad | \$ 0 |
| Insurance | \$ 0 |

DATE SUBMITTED: September, 2000

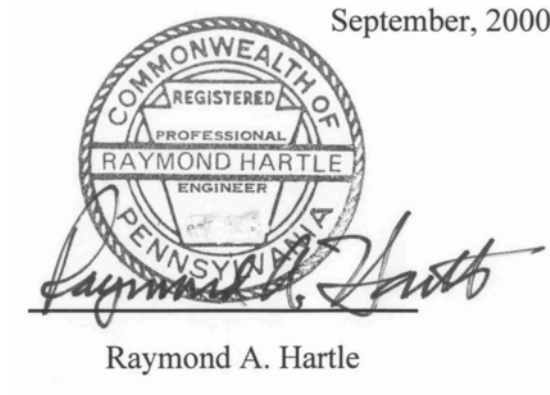


TABLE OF CONTENTS

I Location Map

II Introduction

III Inspection Findings

- Inspection Summary
- Photographs
- Drawings *(Note – Drawings for this structure are not included here.)*
- Forms D-450's

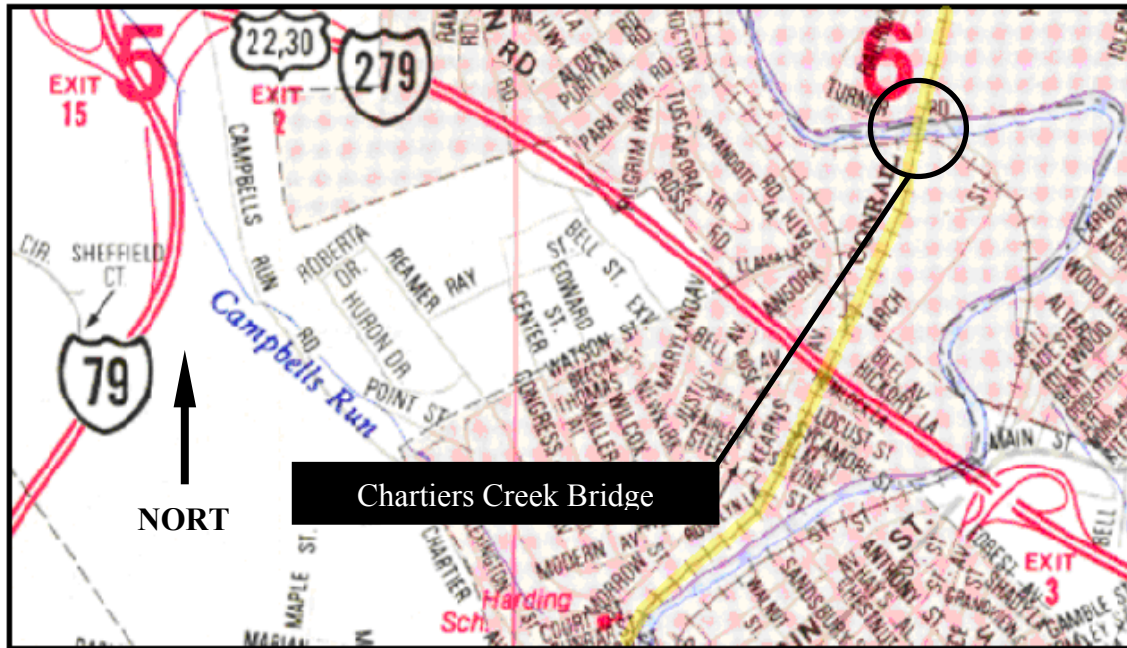
IV Structural Analysis

V Recommendations And Cost Estimate

VI Appendix

- BMS Forms D-491's *(Note – Not included in this example.)*

Chartiers Creek Bridge



Location Map (No Scale)

**REPORT ON THE INITIAL NBIS INSPECTION
OF
CHARTIERS CREEK BRIDGE**

PORT AUTHORITY OF ALLEGHENY COUNTY

II. INTRODUCTION:

- Location

Located in the Borough of Crafton, the Chartiers Creek Bridge carries two (2) lanes of the Port Authority of Allegheny County's West Busway over Chartiers Creek, and the Pittsburgh Industrial Railroad, Inc.

- Year Built

The approximate date of the original construction of the Chartiers Creek Bridge is 1948. The structure was built by the Pennsylvania Railroad Company. Rehabilitation was completed in July 1997.

- Load Posting

None required.

- Description

The Chartiers Creek Bridge is a three (3) span, non-composite, riveted and bolted built-up plate girder bridge with a total length of 253'-11" (see photo no. 1). The 3 spans consist of one (1) main simple span 124'-0", one (1) simple south end span 55'-3", and one (1) simple north end span 68'-3" long. The span lengths are measured between centerline of bearings. The skew angle measured between the centerline of the abutment and West Busway is 90°. There are AT&T conduits mounted under the deck, and light poles mounted on top of the concrete parapets (see photo no.'s 8 & 2, respectively).

Chartiers Creek Bridge

The superstructure consists of four girders spaced at 7'-0" – 6'-0" – 7'-0" on centers, are laterally restrained with angle cross framing, and support an 8 1/2" reinforced concrete deck. The deck thickness includes a 1/2" integral-wearing surface. The deck measures 28'-0" between the reinforced concrete parapets present on both sides of the structure. Galvanized stay-in-place deck forms are present on the underside of the deck (see photo no. 8).

Span 1 girders are made up of a 5'-11" deep by 1/2" thick web plates, and 18" wide by 3/4" thick top and bottom flange plates (see photo no. 8). The main span consists of a 10' - 4 1/2" deep by 1/2" thick web plate, and top and bottom flange plates varying from 20" wide by 7/8" thick, to 20" wide by 1" thick (see photo no. 9). Span 3 girders are made up of a 6' - 10 1/2" deep by 1/2" thick web plate, and 18" wide by 3/4" and 7/8" thick top and bottom flange plates (see photo no. 10). New knee brackets, bolted to the fascia girders, measure 4'-9" wide, from the centerline of existing fascia girders to the centerline of the new W24x55 fascia stringers, with 1/2" thick web plates, and 6" wide by 1/2" thick top and bottom flange plates (see photo no. 4). Lateral bracing and diaphragms consist of angles, and angle x-bracing, respectively. Laminated elastomeric bearing pads are present at the girder ends.

The main span vertical underclearance, from the existing concrete channel bottom, at the centerline of the railroad measures 60'-9" and 36'-7" in span 1.

Gravity type substructures consist of a combination of original stone construction with newly constructed reinforced concrete abutment backwalls and pier caps (see photo no.'s 4 to 7).

Chartiers Creek Bridge

III. INSPECTION FINDINGS:

Michael Baker Jr., Inc. performed this initial inspection, which follows NBIS procedures, on June 23, 2000, via a UB-40 underbridge inspection crane. In general, the structure was in good condition with a few minor problems. Several conduits at the south abutment and in span 1 have severely buckled segments, and broken couplers and/or adapters (see photo no.'s 12 & 13). In addition, a conduit in span 3 is split and leaking water (see photo no. 14). These problems are due to the junction boxes being allowed to fill with rainwater during construction.

Approach

The north and south approach roadway and slabs are newly constructed with no deficiencies noted.

Deck

No deficiencies noted – new construction (see photo no. 11). All PennDOT Type 1 scuppers are in excellent condition. A few scuppers exhibit minor debris accumulation but are fully functional (see photo no. 15). Random hairline ($< 0.01''$) shrinkage cracks along the length of the concrete parapets are present (see photo no. 16). Deck expansion joints consist of strip seals in good condition with minor debris accumulation (see photo no. 17).

Superstructure

The superstructure has no visible structural deficiencies. Girders, fascia stringers, knee brackets, and lateral bracing are newly painted. The paint shows no visual defects, but the girders and bracing exhibit evidence of prior minor section loss and member pitting. Fascia stringers and knee brackets are in new condition with no deficiencies noted (see photo no. 4). Diaphragms are in good condition, but show areas of freckled surface rust under the broken

Chartiers Creek Bridge

conduit in span 1. Approximately 50% of lateral bracing connections between girders 3 & 4, in span 2, were not painted with final paint coat (see photo no. 18). Laminated elastomeric bearing pads are functioning properly with no problems noted.

Substructure

The north and south abutments are in good condition, with a few minor problems noted. Both abutments have newly constructed reinforced concrete backwalls, bridge seats, and wingwalls with no visual deficiencies noted (see photo no.'s 4 & 5). The stem tops consist of new reinforced concrete construction, also with no visual deficiencies noted, and are attached to the existing stone masonry bases. Some locations of the stone masonry show minor cracking and loosening of mortar.

Piers 1 & 2 are in good condition with minor cracking and loosening of mortar on the existing stone masonry portion of the stems. The bridge seats, caps, and stem tops are newly constructed reinforced concrete with no visual deficiencies noted (see photo no.'s 6 & 7).

Chartiers Creek Bridge



Photo No. 1 General Elevation (Upstream)



Photo No.2 South Approach (near)

Chartiers Creek Bridge



Photo No.3 North Approach (far)



Photo No.4 South Abutment (near) - Elevation

Chartiers Creek Bridge



Photo No.5 North Abutment (far) - Elevation



Photo No.6 Pier 1 - North Face (Looking South)

Chartiers Creek Bridge



Photo No.7 Pier 2 - North Face (Looking South), note electrical lines



Photo No.8 General Underside View – Span 1

Chartiers Creek Bridge



Photo No.9 General Underside View – Span 2



Photo No. 10 General Underside View – Span 3

Chartiers Creek Bridge



Photo No. 11 General Deck View



Photo No. 12 Conduit, Span 1 – note longitudinal crack/split

Chartiers Creek Bridge



Photo No. 13 Conduit and Couplers, Span 1 – note bend in conduit, and coupler separation



Photo No.14 Conduit , Span 3 – note conduit is split and leaking water

Chartiers Creek Bridge



Photo No. 15 Typical PennDOT Type 1 Scupper



Photo No.16 Typical parapet crack

Chartiers Creek Bridge

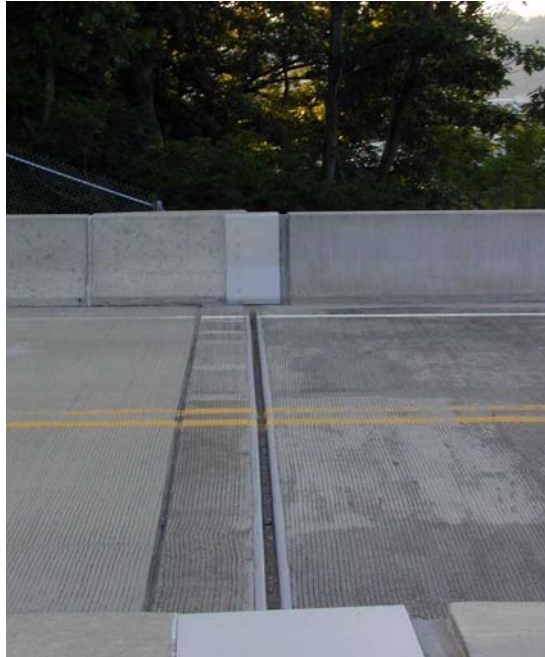


Photo No. 17 Strip Seal at North Abutment (typ.) – note minor debris accumulation



Photo No.18 Lateral bracing connection between beam #3 and #4, in span 2 – note no final paint coat, and rust freckles

Chartiers Creek Bridge

IV. STRUCTURAL ANALYSIS:

Bridge Load Ratings (Tons)

| LOAD FACTOR | H | HS | ML | P |
|---------------------|-----|-----|-----|-----|
| Inventory w/o F.W.S | 115 | 159 | 152 | --- |
| Inventory w/ F.W.S | 112 | 155 | 148 | --- |
| Operating w/o F.W.S | 191 | 265 | 253 | 346 |
| Operating w/ F.W.S | 187 | 259 | 247 | 338 |

Note: 1) Critical rating is for a beam controlled by shear in span 3
2) Due to no analysis being performed as part of the inspection, the above table is reproduced from contract drawings.

V. RECOMMENDATIONS AND COST ESTIMATE:

Repairs

| Item | Estimated Quantity | Unit Cost | Total Cost |
|---|--------------------|-----------|------------|
| Drain junction boxes, and conduits filled with water. Repair bent conduits, and broken couplers/adapters. | N/A | Lump Sum | \$5,000.00 |
| Paint locations requiring final paint coat between girders 3 & 4 in span 2. | 20 SF | Lump Sum | \$1,000.00 |

TOTAL COST \$6,000.00

Note: The above costs are only for the items listed and do not include additional costs which would be incurred when the work is performed, such as mobilization, maintenance and traffic protection, engineering, etc.

Site Data

BRIDGE MANAGEMENT SYSTEM
BRIDGE INSPECTION REPORTBMS Updated
by _____ Date _____

| | | | | | | | | | | | | | | | | | | | | | |
|------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|-----|------------------------|---|---|---|---|---|
| A01 | 0 | 2 | 7 | 4 | 2 | 1 | 0 | 0 | 0 | 0 | 9 | 0 | 6 | 1 | C05 | Structure Type (Dept.) | 1 | 9 | 1 | 1 | 0 |
| Main | | | | | | | | | | | | | | | | STL. RIVETED I-BEAM | | | | | |

CHARTIERS CREEK BRIDGE Over CHARTIERS CREEK Approach

Inspection Date: E06 0 6 2 3 0 0 Name of Consultant and/or Inspectors: E12 M I C H A E L B A K E R J R., I N C.

Inspection Type: E07 1 Inspected by: E08 8 Hired by: E13 8 Time started: 7:30 A.M. Weather Conditions: Temp: 84

CRAFTON

Time completed: 4:30 P.M.

MOSTLY SUNNY

☐ City ☒ Borough ☐ TownshipOptional Reminder:
Check boxes if Maintenance
Activities are needed -->

X

Bridge Signing Verification

| BMS Item | Type of Sign | Required Sign | Near Advance | SIGNING IN FIELD | | Far Advance | Comments |
|----------|-----------------------|---------------|--------------|------------------|-----|-------------|-------------|
| | | | | Near | Far | | |
| D15 | Bridge Weight Limit | N/A T | | | | | NONE POSTED |
| D15 | Except Combination | N/A T | | | | | |
| D14 | One Truck at a Time | Yes / (No) | | | | | |
| B22/B23 | Vert. Clearance - On | N/A | | | | | See Sketch |
| B22/B23 | Vert. Clearance - Und | N/A | | | | | See Sketch |
| | One Lane Bridge | Yes / (No) | (Opt) | | | (Opt) | |
| | Narrow Bridge | Yes / (No) | (Opt) | | | (Opt) | |
| | Hazard Clearance | Yes / (No) | | | | | |
| | Other | | | | | | |
| (Opt) | Other | | | | | | |

Key --> OK: Signs properly installed M: Signs missing D: Signs damaged / incorrect New Wearing Surface Under Bridge: YES ☐ NO ☐

Notes

Vert. Clear. Sign On Feature: B01 = B31 = Under Feature: B01 = B31 =

E26 Underclearance Appraisal 5 Controlling: Lateral 12'-2" Vertical 36'-7"

E28-A Traffic Safety Features (Subfields shown vertically) Posted Speed Limit mph

6 Bridge Railing PARAPET - JERSEY BARRIER. (GOOD CONDITION - MINOR CRACKING THROUGHOUT)

8 Transition PARAPET EXTENSIONS.

8 Approach Guiderail ON RIGHT - CONTINUOUS NJ BARRIER - GOOD. W-BEAM AND STL. POSTS ON NEAR LT. AND FAR LT.

6 Approach Rail Ends FLARED AND TURNED DOWN W-BEAM ON NEAR LT. AND FAR LT.

E28 Approach Alignment 8 NO SPEED REDUCTION. GOOD SIGHT DISTANCE.

E15 Approach Roadway 8 NEW PAVEMENT GOOD CONDITION.

Pavement GOOD

Drainage GOOD (ALL NEW CONSTRUCTION)

Shoulders GOOD

E14 Approach Slab 8 NEW CONSTRUCTION.

Bump at Bridge Yes ☐ No ☒

C19 Relief Joint 1

Bridge 1 Data

Inspection Date

(DEC 1996)

A01

0 2

7 4 2 1

0 0 0 0

9 0 6 1

E06

0 6 2 3 0 0

For Non-State Roadways

B01

B27

B28

B30A

Ref

ADT

ADT YR

ADTT %

For State highways, data from
RMS will be used.

E25

Deck Geometry

6

Table

Controlling Values:

B27 / B34 / B22

A31 / A31 / B18

Design Exception granted ?

E16

Deck Wearing Surface

9

NEW CONSTRUCTION (CONCRETE INTEGRAL)

C10

Wearing Surface Type

1 0 1

C10A

Wearing Surface Thickness

0 5

E17

Deck

9

Estimated Spall or Delamination

%

Est. Chloride Content

Top EXCELLENT CONDITION - NEW CONSTRUCTION.

Underside

STAY IN PLACE FORMS (NO RUSTING NOTED) GALVANIZED AND IN GOOD CONDITION.

Exp Joint

No.

4

C22

Exp Jt Types

M B G

GOOD CONDITION - SOME MINOR DIRT BUILD UP. (STRIP SEALS)

Deck Drainage

GOOD - SOME SCUPPERS HAVE DEBRIS BUT NOT IN THE DOWNSPOUT.

E18

Superstructure

7

See Sheet

for Additional Details.

Form 491-J attached for FCM details Yes/No

Girders / Beams

GOOD CONDITION - SUPERSTRUCTURE HAS BEEN RECONSTRUCTED FOR NEW BUSWAY BRIDGE. NEW PAINT/COATING OVER PREVIOUS PITTING/MORE SECTION LOSS. ALSO, SOME AREAS OVER LIGHT SURFACE RUST ON BOTTOM FLANGE. (THROUGHOUT)

Floorbeams

N/A

Stringers

NEW (FASCIA STRINGERS) W24 X 55 EXCELLENT CONDITION.

Diaphragms

GOOD CONDITION. FEW AREAS OF FRECKLED SURFACE RUST UNDER BROKEN CONDUIT IN SPAN 1.

Truss Members

N/A

Portals / Bracing

FEW AREAS OF FRECKLED SURFACE RUST UNDER BROKEN CONDUIT IN SPAN 1. SEVERAL AREAS BETWEEN G3 AND G4 IN SPAN 2 WERE NOT PAINTED WITH FINAL COAT.

Bearings

GOOD CONDITION. (LAMINATED ELASTOMERIC)

Drainage System (Below Deck)

EXCELLENT CONDITION. (TYPE 1 SCUPPERS)

Abutment Data

Inspection Date

(DEC 1996)

A01

0

2

7

4

2

1

0

0

0

0

9

0

6

1

E06

0

6

2

3

0

0

E20

Substructure

7

Details on Sheet

NAB - Near Abutment (Use same notation as W09)

Backwall GOOD CONDITION - NEW CONSTRUCTION.

Bridge Seats GOOD CONDITION - NEW CONSTRUCTION. VERY MINOR DEBRIS.

Cheekwalls

Stem GOOD CONDITION - NEW CONCRETE CONSTRUCTION AT TOP ON EXISTING STONE MASONRY BASE. SOME LOCATIONS HAVE MINOR CRACKING AND LOOSENING OF MORTAR.

Wings GOOD CONDITION - NEW CONSTRUCTION.

Footing NOT VISIBLE.

Piles NOT VISIBLE.

Scour / Undermine

Yes

☐

No

☒

See Details on Form

Sheet

ABUTMENT IS NOT IN CHANNEL. ALSO, CHANNEL IS CONCRETE LINED.

Settlement NONE NOTED.

Embank-Slope-Wall GOOD CONDITION - HEAVY VEGETATION.

Wall Drainage

FAB - Far Abutment (Use same notation as W09)

Backwall GOOD CONDITION - NEW CONSTRUCTION.

Bridge Seats GOOD CONDITION - NEW CONSTRUCTION. MINOR DEBRIS.

Cheekwalls

Stem GOOD CONDITION - SAME AS NEAR ABUTMENT.

Wings GOOD CONDITION - NEW CONSTRUCTION.

Footing NOT VISIBLE.

Piles NOT VISIBLE.

Scour / Undermine

Yes

☐

No

☒

See Details on Form

Sheet

ABUTMENT IS NOT IN THE CHANNEL.

Settlement NONE NOTED.

Embank-Slope-Wall HEAVY VEGETATION.

Wall Drainage

Pier Data

Inspection Date

(DEC 1996)

A01

0

2

7

4

2

1

0

0

0

0

9

0

6

1

E06

0

6

2

3

0

0

Substructure (Cont.)

Pier / Bent Number 1 (Use same notation as W09)Bridge Seats GOOD CONDITION - NEW CONSTRUCTION.Caps GOOD CONDITION - NEW CONSTRUCTION.

Cheekwalls

Columns/Stems GOOD CONDITION - NEW CONSTRUCTION ON TOP OF EXISTING STONE MASONRY BASE. MINOR CRACKING AND LOOSE MORTAR.Footings NOT VISIBLE.Piles NOT VISIBLE.Scour / Undermine Yes ☐ No ☒ See Details on Form _____ Sheet _____NOT IN CHANNEL - CHANNEL IS CONCRETE LINED.Settlement NONE NOTED.Pier / Bent Number 2 (Use same notation as W09)Bridge Seats GOOD CONDITION - NEW CONSTRUCTION.Caps GOOD CONDITION - NEW CONSTRUCTION.

Cheekwalls

Columns/Stems GOOD CONDITION - SAME AS PIER 1.Footings NOT VISIBLE.Piles NOT VISIBLE.Scour / Undermine Yes ☐ No ☒ See Details on Form _____ Sheet _____CHANNEL IS CONCRETE LINED.Settlement NONE NOTED.

Waterway 1 Data

BRIDGE MANAGEMENT SYSTEM
BRIDGE INSPECTION REPORTBMS Updated
by _____ Date _____

| | | | | | | | | | | | | | | | | | | | | | |
|-----|---|---|---|---|---|---|---|---|---|---|---|---|---|---|-------|--|--|--|--|--|--|
| A01 | 0 | 2 | 7 | 4 | 2 | 1 | 0 | 0 | 0 | 0 | 9 | 0 | 6 | 1 | W01-A | | | | | | |
|-----|---|---|---|---|---|---|---|---|---|---|---|---|---|---|-------|--|--|--|--|--|--|

| | | | | | | | | | | | | | | | | | | | | | |
|-----------------|--|----------------------|--|--------------------------|--|--------------------------|--|--------------|--|--------------------|--|--|--|--|--|--|--|--|--|--|--|
| Over | | | | | | | | | | Weather Conditions | | | | | | | | | | | |
| Inspection Type | | U.W. Inspection Type | | Regular U.W. Insp. Freq. | | Interim U.W. Insp. Freq. | | Time started | | | | | | | | | | | | | |
| W02 | | N | | W02-A | | W03 | | W04 | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|--------------------------------------|--|--|--|--|--|--|--|--|--|----------|--|--|--|--|--|--|--|--|--|-----------------|--|--|--|--|--|--|--|--|--|
| Name of Consultant and/or Inspectors | | | | | | | | | | Hired by | | | | | | | | | | Inspection Cost | | | | | | | | | |
| W16 | | | | | | | | | | W17 | | | | | | | | | | W15 | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

| | | | | | | | | | | | | | | | | | | | |
|--|--|--|--|--|--|--|--|--|--|------------------------|--|--|--|--|--|--|--|--|--|
| Scour Critical Rating | | | | | | | | | | No. of Units Inspected | | | | | | | | | |
| E29A W06 9 based on: <input checked="" type="checkbox"/> Observed Scour <input type="checkbox"/> Scour Calculation | | | | | | | | | | W14 | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | |

| | | | | | | | | | |
|--------------------------------|--|--|--|--|--|--|--|--|--|
| Streambed Material (36 SPACES) | | | | | | | | | |
| W07 C 8 CONCRET LINED CHANNEL. | | | | | | | | | |
| | | | | | | | | | |

| | | | |
|-----|---|---|------------------|
| E21 | Channel/Channel Protection - Cond. Rating | 7 | Details on Sheet |
|-----|---|---|------------------|

Channel CHANNEL IS LINED WITH CONCRETE.

Banks GOOD CONDITION - HEAVY VEGETATION.

Streambed Movements NONE NOTED.

Debris, Vegetation SOME DEBRIS IN CHANNEL.

River (Stream) Control Devices N/A

Embankment / Streambed Controls N/A

Drift, Other NONE NOTED.

| | | |
|--|-------------------|---|
| E27 | Waterway Adequacy | 9 |
| Risk of Overtopping <input checked="" type="checkbox"/> Remote <input type="checkbox"/> Slight <input type="checkbox"/> Occasional <input type="checkbox"/> Frequent | | |
| Traffic Delay <input checked="" type="checkbox"/> Insignificant <input type="checkbox"/> Significant <input type="checkbox"/> Severe | | |
| B18 - Functional Class. | | |
| High Water Mark: ELEV: _____ DATE (mm/yyyy) _____ <input type="checkbox"/> New HW Mark <input type="checkbox"/> HW since last inspection | | |

| | | | | | | |
|-------------------|-----------------|-------------|-----------------------|---------------------|----------------|------------------|
| W09 | W10 | W11 | W11-A | W11-B | W11-C | W11-F |
| Substructure Unit | Foundation Type | Water Depth | Observed Scour Rating | U.W. Insp Performed | Observed Depth | Counter-Measures |
| N A B | P | 0 0 | 9 | E | 0 0 0 | |

Findings: ABUTMENT OUT OF FLOOD PLANE.

| | | | | | | |
|-------------------|-----------------|-------------|-----------------------|---------------------|----------------|------------------|
| W09 | W10 | W11 | W11-A | W11-B | W11-C | W11-F |
| Substructure Unit | Foundation Type | Water Depth | Observed Scour Rating | U.W. Insp Performed | Observed Depth | Counter-Measures |
| P 0 1 | P | 0 0 | 9 | E | 0 0 0 | |

Findings:

Waterway 2 Data

U.W. Inspection Date

| | | | | | | | | | | | | | | | | | | | | | |
|-----------------------------|---------------------------|-----------------------|-----------------------------------|---------------------------------|----------------------------|-------------------------------|---|---|---|---|---|---|---|---|-------|--|--|--|--|--|--|
| A01 | 0 | 2 | 7 | 4 | 2 | 1 | 0 | 0 | 0 | 0 | 9 | 0 | 6 | 1 | W01-A | | | | | | |
| W09 Substructure Unit | W10 Foundation Type | W11 Water Depth | W11-A Observed Scour Rating | W11-B U.W. Insp Performed | W11-C Observed Depth | W11-F Counter- Measures | | | | | | | | | | | | | | | |
| P | 0 | 2 | | | | | | | | | | | | | | | | | | | |
| | P | 0 | 0 | 9 | E | 0 | 0 | 0 | | | | | | | | | | | | | |

Findings: _____

| | | | | | | | | | | | | | | | | | | | | | |
|-----------------------------|---------------------------|-----------------------|-----------------------------------|---------------------------------|----------------------------|-------------------------------|---|---|--|--|--|--|--|--|--|--|--|--|--|--|--|
| W09 Substructure Unit | W10 Foundation Type | W11 Water Depth | W11-A Observed Scour Rating | W11-B U.W. Insp Performed | W11-C Observed Depth | W11-F Counter- Measures | | | | | | | | | | | | | | | |
| F | A | B | | | | | | | | | | | | | | | | | | | |
| | P | 0 | 0 | 9 | E | 0 | 0 | 0 | | | | | | | | | | | | | |

Findings: ABUTMENT OUT OF FLOOD PLANE.

| | | | | | | | | | | | | | | | | | | | | | |
|-----------------------------|---------------------------|-----------------------|-----------------------------------|---------------------------------|----------------------------|-------------------------------|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|
| W09 Substructure Unit | W10 Foundation Type | W11 Water Depth | W11-A Observed Scour Rating | W11-B U.W. Insp Performed | W11-C Observed Depth | W11-F Counter- Measures | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |

Findings: _____

| | | | | | | | | | | | | | | | | | | | | | |
|-----------------------------|---------------------------|-----------------------|-----------------------------------|---------------------------------|----------------------------|-------------------------------|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|
| W09 Substructure Unit | W10 Foundation Type | W11 Water Depth | W11-A Observed Scour Rating | W11-B U.W. Insp Performed | W11-C Observed Depth | W11-F Counter- Measures | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |

Findings: _____

| | | | | | | | | | | | | | | | | | | | | | |
|-----------------------------|---------------------------|-----------------------|-----------------------------------|---------------------------------|----------------------------|-------------------------------|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|
| W09 Substructure Unit | W10 Foundation Type | W11 Water Depth | W11-A Observed Scour Rating | W11-B U.W. Insp Performed | W11-C Observed Depth | W11-F Counter- Measures | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |

Findings: _____

| | | | | | | | | | | | | | | | | | | | | | |
|-----------------------------|---------------------------|-----------------------|-----------------------------------|---------------------------------|----------------------------|-------------------------------|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|
| W09 Substructure Unit | W10 Foundation Type | W11 Water Depth | W11-A Observed Scour Rating | W11-B U.W. Insp Performed | W11-C Observed Depth | W11-F Counter- Measures | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |

Findings: _____

(DEC 1996)

U.W. Inspection Date

| | | | | | | | | | | | | | | | | | | | | |
|-----|---|---|---|---|---|---|---|---|---|---|---|---|---|---|-------|--|--|--|--|--|
| A01 | 0 | 2 | 7 | 4 | 2 | 1 | 0 | 0 | 0 | 0 | 9 | 0 | 6 | 1 | W01-A | | | | | |
|-----|---|---|---|---|---|---|---|---|---|---|---|---|---|---|-------|--|--|--|--|--|

OBSERVED SCOUR RATING GUIDE

| Rating | ITEM NUMBER | | | | | | | | Rating |
|--------|--|------------|------------------|---------------------------|---------------------------|----------|-----------|------------------------|--------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | |
| | Change Since Last Inspection | Scour Hole | Debris Potential | Substructure Scourability | Opening Adequacy/ Channel | Sediment | Alignment | Velocity/ Stream Slope | |
| 9 | None | None | None | NF/P9/R9 | Good | None | Good | Low | 9 |
| 8 | None | Minor | None | P8/C8/R8 | Good | Minor | Good | Low | 8 |
| 7 | Minor | Minor | Minor | P7/C7/R7 | Fair | Minor | Good | Medium | 7 |
| 6 | Minor | Advanced | Medium* | A6 | Fair | Medium | Medium | Medium | 6 |
| 5 | Medium* | Advanced | High* | A5 | Fair | High | Medium | High | 5 |
| 4 | Medium | Serious* | High | R4*/A4* | Poor* | High | Poor*+ | High | 4 |
| 3 | High* | Serious* | Present* | A3 | Overtop* | High | Poor | High | 3 |
| 2 | Bridge is scour critical, IMMEDIATE action is required * | | | | | | | | 2 |
| 1 | Bridge is scour critical, bridge is CLOSED * | | | | | | | | 1 |
| 0 | Bridge has failed due to scour * | | | | | | | | 0 |

NOTES:

C = Effective Countermeasures

P = Pile Supported Substructures

Rating considerations given in highest to lowest level of importance from left to right.

* If an item is so marked, it cannot be given a higher ranking.

s founded on competent rock and no problems exist.

DETERMINATION OF RATING FOR BMS ITEM

W11-A

[illegible]

If Underwater Inspection only

Signatures and Date:

Bridge 2 Data

Inspection Date

(DEC 1996)

| | | | | | | | | | | | | | | | | | | | | | |
|-----|---|---|---|---|---|---|---|---|---|---|---|---|---|---|-----|---|---|---|---|---|---|
| A01 | 0 | 2 | 7 | 4 | 2 | 1 | 0 | 0 | 0 | 0 | 9 | 0 | 6 | 1 | E06 | 0 | 6 | 2 | 3 | 0 | 0 |
|-----|---|---|---|---|---|---|---|---|---|---|---|---|---|---|-----|---|---|---|---|---|---|

| | | | | | | | | | | | | | | |
|-----|-----------------|---|---|---------------|---------|--------------------------|------|--------------------------|------|-------------------------------------|------|--------------------------|---------------------|--------------------------|
| E19 | Paint Condition | 8 | 8 | New Paint Y/N | If Yes: | <input type="checkbox"/> | Spot | <input type="checkbox"/> | Zone | <input checked="" type="checkbox"/> | Full | <input type="checkbox"/> | Revise item G08-G17 | <input type="checkbox"/> |
|-----|-----------------|---|---|---------------|---------|--------------------------|------|--------------------------|------|-------------------------------------|------|--------------------------|---------------------|--------------------------|

Interior Beam / Girder VERY GOOD - RECENTLY REPAINTED.Fascias VERY GOOD - NEW.

Splash Zone: Truss / Girder

Truss

Bearings VERY GOOD.

Other

| | | | | | |
|-----|---------------------|-------------------------|---|---|----------|
| E23 | Est. Remaining Life | BMS to Calculate Yes/No | 3 | 4 | Comments |
|-----|---------------------|-------------------------|---|---|----------|

| | | | | | | | | | |
|--------------------|-----|-------------------------------------|-----------------------|---------------|--------------------------|-------------------|--------------------------|-------|--------------------------|
| Recalculate IR/OR: | Yes | <input type="checkbox"/> | Due to: | Deterioration | <input type="checkbox"/> | New Wearing Surf. | <input type="checkbox"/> | Other | <input type="checkbox"/> |
| | No | <input checked="" type="checkbox"/> | Previous Rating Dated | | is still valid | | | | |

| | | | | | | | | | | | | | | | | | |
|-----|------------------|---|---|---|---|---|---|---|---|---|--|--|--|--|---|---|---|
| E30 | Inventory Rating | 1 | 9 | 8 | 2 | 9 | 8 | 8 | 9 | 8 | | | | | 2 | 9 | 8 |
|-----|------------------|---|---|---|---|---|---|---|---|---|--|--|--|--|---|---|---|

| | | | | | | | | | | | | | | | | | |
|-----|------------------|---|---|----|---|-------|---|-------|---|-------|--|--|--|----------------|---|---|---|
| E31 | Operating Rating | 1 | 9 | 8 | 2 | 9 | 8 | 8 | 9 | 8 | | | | | 2 | 9 | 8 |
| | | H | | HS | | ML-80 | | Other | | Other | | | | HS Load Factor | | | |

| | | | | | | | | | | | | | | | |
|-----|-----------|---|---|-----|---------|---|--------|-----|------|---|---|-----|--------|---|---|
| E32 | Rate Meth | 2 | S | E33 | Typ Mem | 1 | AASHTO | E37 | Spec | 9 | 4 | E38 | Manual | 9 | 4 |
|-----|-----------|---|---|-----|---------|---|--------|-----|------|---|---|-----|--------|---|---|

| | | | | | | | | | | |
|-----|-------------|---|--------------|---|--|----|--|------|-------------------------------------|-----------------------|
| E29 | Bridge Post | 9 | CONTROLLING: | H | | HS | | ML80 | <input checked="" type="checkbox"/> | Engineering Judgement |
|-----|-------------|---|--------------|---|--|----|--|------|-------------------------------------|-----------------------|

| | | | | | | | | | |
|-----|--------------------------------|----|------------|--------------------------|---------|---------|-------------|--------|--|
| E24 | Structural Condition Appraisal | 7 | Based upon | <input type="checkbox"/> | Table 1 | B27-ADT | | B30-IR | |
| | | or | E18-Super | 7 | E20-Sub | 7 | E22-Culvert | | |

| | | | | | | | |
|-----|------------------|---|---|-----|-------------------|---|-----------------------|
| E01 | Next Insp. Freq. | 2 | 4 | E03 | Equip. Next Insp. | B | SNOOPER TRUCK (UB-40) |
|-----|------------------|---|---|-----|-------------------|---|-----------------------|

| | | | | | | | |
|-----|------------------|--|-----|---------|--|--|--|
| E04 | Spec. Insp. Type | | E05 | By Date | | | |
|-----|------------------|--|-----|---------|--|--|--|

| | | | | | |
|-----------------------|-------------------------------------|------|-----|-----|---------------------------------|
| Is bridge over water? | <input checked="" type="checkbox"/> | Yes. | E22 | = N | Complete Forms D-450E through G |
| | <input type="checkbox"/> | No. | E22 | = N | E21 = N E27 = N E29A = N |

Notes: ONE SPAN IS OVER WATER AND ONE SPAN IS OVER RAILROAD.
HAD RAILROAD REPRESENTATIVE ON SITE. CREW WAS OUT OF SPAN 1 (RR LOCATION) BY TIME REQUIRED. (9 A.M.)
INSPECTION WAS FIRST ON NEWLY CONSTRUCTED BUSWAY BRIDGE WHICH USED AN EXISTING RR BRIDGE. CONDUITS ON BRIDGE WERE BUSTED AT ADAPTERS AT ABUTMENT 1. ALSO, ONE EXPANSION COUPLER WAS BROKEN AND NEEDED REPLACED. SEVERAL CONDUIT SEGMENTS IN SPAN 1 WERE SEVERELY BUCKLED AND NEEDED REPLACED.

 Signatures and Date: PATRICK LEACH, P.E. - 6/23/00
 CHARLES MOLNAR - 6/23/00

Maintenance Needs Data

Inspection Date

(DEC 1996)

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|------------|----------|----------|------------|----------|----------|------------|----------|----------|------------|----------|----------|------------|----------|----------|------------|----------|----------|------------|----------|----------|------------|--|--|------------|--|--|------------|--|--|
| A01 | 0 | 2 | 7 | 4 | 2 | 1 | 0 | 0 | 0 | 0 | 9 | 0 | 6 | 1 | E06 | 0 | 6 | 2 | 3 | 0 | 0 | | | | | | | | |
| H01 | | | H03 | | | H05 | | | H08 | | | H09 | | | H01 | | | H03 | | | H05 | | | H08 | | | H09 | | |

Approach Roadway Work

| Item # | Location | Quantity | PR | D/C |
|-------------------------------|---------------------|----------|----|-----|
| Pavement (Patch/Raise) | RDPAYMT L N R L F R | SY | | |
| Pavement Relief Jt (Rep/Repl) | RDRLFJT L N R L F R | SY | | |
| Shoulders (Repair/Reconstr) | RDSHLDR L N R L F R | SY | | |
| Drainage-Off Bridge (Improve) | RDDRAIN L N R L F R | EA | | |
| GR/Trans/End (Rep/Repl/Imp) | RDGDERL L N R L F R | EA | | |
| Load Limit Signs (Replace) | RDLDSGN L N R L F R | EA | | |
| Clearance Signs (Replace) | RDCLSGN L N R L F R | EA | | |
| Cut Brush to Clear Signs | RDBRUSH L N R L F R | EA | | |
| Approach Slab (Replace) | A744201 L N R L F R | SY | | |

Cleaning - Flushing

| | | | | | |
|---------------------------|---------|-------------|----|--|--|
| Deck | A743101 | -- -- | EB | | |
| Scupper/Down Spouting | B743101 | 1 2 3 4 5 O | EB | | |
| Bearing/Bearing Seat | C743102 | 1 2 3 4 5 O | EB | | |
| Steel-Horizontal Surfaces | D743102 | 1 2 3 4 5 O | EB | | |

Deck

| | | | | | |
|------------------------------|---------|-------------|----|--|--|
| Bitum Deck W Surf (Rep/Repl) | BITWRGS | 1 2 3 4 5 O | SY | | |
| Timber Deck (Rep/Repl) | B744301 | 1 2 3 4 5 O | SY | | |
| Open Steel Grid (Rep/Repl) | C744302 | 1 2 3 4 5 O | SY | | |
| Concrete Deck (Repair) | D744303 | 1 2 3 4 5 O | SY | | |
| Concrete Sidewalk (Repair) | E744303 | 1 2 3 4 5 O | SY | | |
| Concrete Curb/Parapet (Rep) | F744303 | 1 2 3 4 5 O | SY | | |

Deck Joints - Expansion Joints

| | | | | | |
|------------------------------|---------|-------------|----|--|--|
| Reseal | A743301 | N 1 2 3 O F | LF | | |
| Repair/Reseal | A744101 | N 1 2 3 O F | LF | | |
| Compression Seal (Rep/Rehab) | B744102 | N 1 2 3 O F | LF | | |
| Modular Dam (Rep/Rehab) | C744102 | N 1 2 3 O F | LF | | |
| Steel Dams (Rep/Rehab) | D744102 | N 1 2 3 O F | LF | | |
| Other Types (Rep/Rehab) | E744102 | N 1 2 3 O F | LF | | |

Bridge Railings - Parapets

| | | | | | |
|----------------------------|----------|-------------|----|--|--|
| Bridge Parapet (Rep/Repl) | RLGBRPR | N 1 2 3 O F | LF | | |
| Struct Mount GR (Rep/Repl) | RLGSTRM | N 1 2 3 O F | LF | | |
| Pedestrian (Rep/Repl) | RLGSPEDN | N 1 2 3 O F | LF | | |
| Median Barrier (Rep/Repl) | RLGMEDB | 1 2 3 4 5 O | LF | | |

Deck Drainage

| | | | | | |
|-------------------------|---------|-------------|----|--|--|
| Scupper Grate (Replace) | DRNGRAT | 1 2 3 4 5 O | EA | | |
| Drain/Scupper (Install) | B744401 | 1 2 3 4 5 O | EA | | |
| Downspouting (Rep/Repl) | C744402 | N 1 2 3 O F | EA | | |

Bearings

| | | | | | |
|-----------------------------|---------|-------------|----|--|--|
| Lubricate | A743501 | N 1 2 3 O F | EA | | |
| Steel (Rep/Rehab) | A744501 | N 1 2 3 O F | EA | | |
| Steel (Replace) | B744501 | N 1 2 3 O F | EA | | |
| Expansion (Reset) | C744502 | N 1 2 3 O F | EA | | |
| Pedestal/Seat (Reconstruct) | D744503 | N 1 2 3 O F | EA | | |

Timber

| | | | | | |
|--------------------------|---------|-------------|----|--|--|
| Stringer (Rep/Repl) | A744601 | 1 2 3 4 5 O | EA | | |
| Other Members (Rep/Repl) | B744601 | 1 2 3 4 5 O | EA | | |

REP..... Repair REPL..... Replace IMP..... Improve
 N..... Near UP..... Upstream LNR..... Near Left/Right
 F..... Far DN..... Downstream LFR..... Far Left/Right
 O..... Other UN..... Under 1,2,3, etc..... Span/Pier No.
 IN..... Inlet OUT..... Outlet EB..... Each Bridge (site)

MAJOR IMPROVEMENT NEEDS

| | | | | | | | | | | | | | | |
|------------|--------------------|--|--|--|--|--|------------|---------------------------|--|--|--|--|--|--|
| F01 | Year Needed | | | | | | F04 | Improvement Length | | | | | | |
| F02 | Type Work | | | | | | F06 | Bridge Width | | | | | | |
| F10 | Future ADT | | | | | | F11 | Future ADT Year | | | | | | |

Steel

| Item # | Location | Quantity | PR | D/C |
|-------------------------------|---------------------|----------|----|-----|
| Stringer (Rep/Repl) | A744602 1 2 3 4 5 O | EA | | |
| Floorbeam (Rep/Repl) | B744602 1 2 3 4 5 O | EA | | |
| Girder (Repair) | C744602 1 2 3 4 5 O | EA | | |
| Diaph/Lat. Bracing (Rep/Repl) | D744602 1 2 3 4 5 O | EA | | |

Reinforced, PS, PC, and PT Concrete

| | | | | |
|--------------------------|---------------------|----|--|--|
| Stringer (Rep/Repl) | A744603 1 2 3 4 5 O | EA | | |
| Diaphragm (Rep/Repl) | B744603 1 2 3 4 5 O | EA | | |
| Other Members (Rep/Repl) | C744603 1 2 3 4 5 O | EA | | |

Truss

| | | | | |
|-------------------------------|---------------------|----|--|--|
| Members (Strengthen/Rep/Repl) | A744701 1 2 3 4 5 O | EA | | |
| Portal (Modify) | B744701 1 2 3 4 5 O | EA | | |
| Members(Tighten/Flameshorten) | C744702 1 2 3 4 5 O | EA | | |

Painting

| | | | | |
|-----------------------|---------------------|----|----------|----------|
| Superstructure - Spot | A743201 1 2 3 4 5 O | EB | 1 | 4 |
| Substructure - Spot | B743201 N 1 2 3 O F | EB | | |
| Superstructure - Full | C743201 1 2 3 4 5 O | EB | | |
| Substructure - Full | D743201 N 1 2 3 O F | EB | | |

Abutment - Wings - Piers

| | | | | |
|--------------------------------|---------------------|----|--|--|
| Backwall (Rep/Repl) | A744801 L N R L F R | CY | | |
| Abutments (Repair) | B744802 L N R L F R | CY | | |
| Wing (Rep/Repl) | C744802 L N R L F R | CY | | |
| Piers (Repair) | D744802 1 2 3 4 5 O | CY | | |
| Footing (Underpin) | E744803 N 1 2 3 O F | CY | | |
| Masonry (Repoint) | F744804 N 1 2 3 O F | LF | | |
| Abut Slopewall (Rep/Repl) | A745101 L N R L F R | SY | | |
| Abut Slopewall (Construct New) | B745102 L N R L F R | CY | | |
| Pile Repair | A745901 N 1 2 3 O F | EA | | |

Scour - Erosion Control

| | | | | |
|-------------------------------|------------------|----|--|--|
| Streambed Paving (Rep/Constr) | A745301 UP UN DN | CY | | |
| Rock Protection | B745301 UP UN DN | CY | | |
| Scour Hole (Backfill) | C745301 UP UN DN | CY | | |
| Stream Deflector (Rep/Constr) | D745302 UP UN DN | CY | | |
| Vegetation/Debris (Remove) | ECREMGV UP UN DN | CY | | |
| Deposition (Remove) | ECREMDP UP UN DN | CY | | |

Culvert

| | | | | |
|------------------------------|----------------|----|--|--|
| Headwall/Wings (Rep/Repl) | A745201 IN OUT | SY | | |
| Apron/Cutoff Wall (Rep/Repl) | B745202 IN OUT | SY | | |
| Barrel (Repair) | C745203 -- -- | SY | | |

FOR COMPLETION BY REVIEW ENGINEER

Apply Protective Coating

| | | | | |
|-----------------------|---------------------|----|--|--|
| Deck/Parapet/Sidewalk | A743401 DK PARA SW | SY | | |
| Substructure | B743401 N 1 2 3 O F | SY | | |

Construct Temporary

| | | | | |
|-----------------------|---------------------|----|--|--|
| Support Pier | A745401 N 1 2 3 O F | EA | | |
| Pipe/Culvert Crossing | B745401 LT CL RT | EB | | |
| Bridge | C745401 LT CL RT | EB | | |

PR - PRIORITY CODE

- 0 - Prompt action required. (Inform Bridge Engineer before updating BMS)
 1 - High Priority, as soon as work can be scheduled.
 2 - Priority, review work plan, adjust schedule if needed.
 3 - Add to scheduled work.
 4 - Routine structural, can be delayed until funds are available.
 5 - Routine non-structural, can be delayed until programmed,

Reviewed On: _____
 By: _____

Chartiers Creek Bridge

Note: The Appendix section for this report is not included here. The BMS 491 Forms for PENNDOT are that state's version of the FHWA SI&A sheet with additional state items. The documents included in the report are typically red marked revisions to the file copy and reflect changes identified during the inspection.

Subpart C - National Bridge Inspection Standards

§ 650.301 Application of standards.

The National Bridge Inspection Standards in this part apply to all structures defined as bridges located on all public roads. In accordance with the AASHTO (American Association of State Highway and Transportation Officials) Transportation Glossary, a bridge is defined as a structure including supports erected over a depression or an obstruction, such as water, high-way, or railway, and having a track or passageway for carrying traffic or other moving loads, and having an opening measured along the center of the roadway of more than 20 feet between undercopings of abutments or spring lines of arches, or extreme ends of openings for multiple boxes; it may also include multiple pipes, where the clear distance between openings is less than half of the smaller contiguous opening.

[44 FR 25435, May 1, 1979. as amended at 51 FR 16834, May 7, 1986]

Federal Highway Administration, DOT

§ 650.303 Inspection procedures.

(a) Each highway department shall include a bridge inspection organization capable of performing inspections, preparing reports, and determining ratings in accordance with the provisions of the AASHTO Manual¹ and the Standards contained herein.

(b) Bridge inspectors shall meet the minimum qualifications stated in § 650.307.

(c) Each structure required to be inspected under the Standards shall be rated as to its safe load carrying capacity in accordance with section 4 of the AASHTO Manual. If it is determined under this rating procedure that the maximum legal load under State law exceeds the load permitted under the Operating Rating, the bridge must be posted in conformity with the AASHTO Manual or in accordance with State law.

(d) Inspection records and bridge inventories shall be prepared and maintained in accordance with the Standards.

(e) The individual in charge of the organizational unit that has been delegated the responsibilities for bridge inspection, reporting and inventory shall determine and designate on the individual inspection and inventory records and maintain a master list of the following:

(1) Those bridges, which contain fracture critical members, the location and description of such members on the bridge and the inspection frequency and procedures for inspection of such members. (Fracture critical members are tension members of a bridge whose failure will probably cause a portion of or the entire bridge to collapse.)

¹ The AASHTO Manual referred to in this part is the Manual for Maintenance Inspection of Bridges 1993 together with subsequent interim changes or the most recent version of the AASHTO Manual published by the American Association of State Highway and Transportation Officials. A copy of the Manual may be examined during normal business hours at the office of each Division Administrator of the Federal Highway Administration, at the office of each Regional Federal Highway Administrator, and at the Washington Headquarters of the Federal Highway Administration. The addresses of those document inspection facilities are set forth in appendix D to part 7 of the regulations of the Office of the Secretary (49 CFR part 7). In addition, a copy of the Manual may be secured upon payment in advance by writing to the American Association of State Highway and Transportation Officials, 444 N. Capitol Street, NW., Suite 225. Washington, DC 20001.

(2) Those bridges with underwater members which cannot be visually evaluated during periods of low flow or examined by feel for condition, integrity and safe load capacity due to excessive water depth or turbidity. These members shall be described, the inspection frequency stated, not to exceed five years, and the inspection procedure specified.

(3) Those bridges, which contain unique or special features requiring additional attention during inspection to ensure the safety of such bridges and the inspection frequency and procedure for inspection of each such feature.

(4) The date of last inspection of the features designated in paragraphs (e)(1) through (3) of this section and a description of the findings and follow-up actions, if necessary, resulting from the most recent inspection of fracture critical details, underwater members or special features of each so designated bridge.

[36 FR 7851, Apr. 27, 1971. Re-designated at 39 FR 10430, Mar. 20, 1974, as amended at 44 FR 25435, May 1, 1979; 53 FR 32W, Aug. 26, 1988]

§ 650.305 Frequency of inspections.

(a) Each bridge is to be inspected at regular intervals not to exceed 2 years in accordance with section 2.3 of the AASHTO Manual.

(b) Certain types or groups of bridges will require inspection at less than 2-year intervals. The depth and frequency to which bridges are to be inspected will depend on such factors as age, traffic characteristics, state of maintenance, and known deficiencies. The evaluation of these factors will be the responsibility of the individual in charge of the inspection program.

(c) The maximum inspection interval may be increased for certain types or groups of bridges where past inspection reports and favorable experience and analysis justify the increased interval of inspection. If a State proposes to inspect some bridges at greater than the specified two-year interval, the State shall submit a detailed proposal and supporting data to the Federal Highway Administrator for approval. The maximum time period between inspections shall not exceed four years.

[36 FR 7851, Apr. 27, 1971. Re-designated at 39 FR 10430, Mar. 20, 1974, as amended at 39 FR 29590, Aug. 16, 1974; 53 FR 32616, Aug. 26, 1988; 57 FR 53281, Nov. 9, 1992]

§ 650.307 Qualifications of personnel.

(a) The individual in charge of the organizational unit that has been delegated the responsibilities for bridge inspection, reporting, and Inventory shall possess the following minimum qualifications:

(1) Be a registered professional engineer; or
(2) Be qualified for registration as a professional engineer under the laws of the State; or

(3) Have a minimum of 10 years experience in bridge inspection assignments in a responsible capacity and have completed a comprehensive training course based on the "Bridge Inspector's Training Manual,"² which has been developed by a joint Federal-State task force, and subsequent additions to the manual.³

² The "Bridge Inspector's Training Manual" may be purchased from the Superintendent of Documents. U.S. Government Printing Office, Washington, DC 20402.

³ The following publications are supplemental to the "Bridge Inspector's Training Manual": "Bridge Inspector's Manual for Movable Bridges." 1977, GPO Stock No. 050-002-00103-5; "Culvert Inspector's Training Manual," July 1986, GPO Stock No. 050-001-0030-7; and "Inspection of Fracture Critical Bridge Members," 1986, GPO Stock No. 050-001-00302-3.

(b) An individual in charge of a bridge inspection team shall possess the following minimum qualifications:

- (1) Have the qualifications specified in paragraph (a) of this section; or
- (2) Have a minimum of 5 years experience in bridge inspection assignments in a responsible capacity and have completed a comprehensive training course based on the "Bridge Inspector's Training Manual," which has been developed by a joint Federal-State task force.
- (3) Current certification as a Level III or IV Bridge Safety Inspector under the National Society of Professional Engineer's program for National Certification in Engineering Technologies (NICET)⁴ is an alternate acceptable means for establishing that a bridge in section team leader is qualified.

[36 FR 7851. Apr. 27, 1971. Re-designated at 39 FR 10430, Mar. 20, 1974. as amended at 44 FR 25435, May 1, 1979; 53 FR 32616. Aug. 26, 1988]

§ 650.309 Inspection report.

The findings and results of bridge inspections shall be recorded on standard forms. The data required to complete the forms and the functions which must be performed to compile the data are contained in section 3 of the AASHTO Manual.

[139 FR 29590, Aug. 16, 1974]

§ 650.311 Inventory.

(a) Each State shall prepare and maintain an inventory of all bridge structures subject to the Standards. Under these Standards, certain structure inventory and appraisal data must be collected and retained within the various departments of the State organization for collection by the Federal Highway Administration as needed. A tabulation of this data is contained in the structure inventory and appraisal sheet distributed by the Federal Highway Administration as part of the Re-cording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges (Coding Guide) In January of 1979. Reporting procedures have been developed by the Federal Highway Administration.

(b) Newly completed structures, modification of existing structures which would alter previously recorded data on the Inventory forms or placement of load restriction signs on the approaches to or at the structure itself shall be entered in the State's inspection reports and the computer inventory file as promptly as practical, but no later than 90 days after the change in the status of the structure for bridges directly under the State's jurisdiction and no later than 180 days after the change in status of the structure for all other bridges on public roads within the State.

[44 FR 25435. May 1, 1979. as amended at 53 FR 32617. Aug. 26, 1988]

⁴ For Information on NICET program certification contact: National Institute for Certification in Engineering Technologies. 1420 King Street. Alexandria, Virginia 22314. Attention: John D. Antrim. P.E. Phone (703) 684-2835.

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GLOSSARY

A

AASHTO - American Association of State Highway and Transportation Officials, name changed from AASHO (American Association of State Highway Officials) in 1973

abrasion - wearing or grinding away of material by friction; usually caused by sand, gravel, or stones, carried by wind or water

absorption - the process of a liquid being taken into a permeable solid (e.g., the wetting of concrete)

abutment - part of bridge substructure at either end of bridge which transfers loads from superstructure to foundation and provides lateral support for the approach roadway embankment

ADT - Average Daily Traffic

ADTT - Average Daily Truck Traffic

admixture - an ingredient added to concrete other than cement, aggregate or water (e.g., air entraining agent)

aggradation - progressive raising of a streambed by deposition of sediment

aggregate - hard inert material such as sand, gravel, or crushed rock that may be combined with a cementing material to form mortar or concrete

air entrainment - the addition of air into a concrete mixture in order to increase the durability and resist thermal forces

alignment - the relative horizontal and vertical positioning between components, such as the bridge and its approaches

alignment bearing - a bearing embedded in a bridge seat to prevent lateral movements (see BEARING)

alligator cracking - cracks initiated by inadequate base support or drainage that form on the surface of a road in adjacent, rectangular shapes (like the skin of an alligator)

alloy - two or more metals, or metal and non-metal, intimately combined, usually by dissolving together in a molten state to form a new base metal

anchorage - the complete assemblage of members and parts, embedded in concrete, rock or other fixed material, designed to hold a portion of a structure in correct position

anchor bolt - a metal rod or bar commonly threaded and fitted with a nut and washer at one end only, used to secure in a fixed position upon the substructure the bearings of a bridge, the base of a column, a pedestal, shoe, or other member of a structure

anchor span - the span that counterbalances and holds in equilibrium the cantilevered portion of an adjacent span; also called the back span; see CANTILEVER BEAM, GIRDER, or TRUSS

angle - a basic member shape, usually steel, in the form of an "L"

anisotropy - the property of certain materials, such as crystals, that exhibits different strengths in different directions

anode - the positively charged pole of a corrosion cell at which oxidation occurs

anti-friction bearing - a ball or roller-type bearing; a bearing that reduces transfer of horizontal loads between components

appraisal rating - a judgment of a bridge component's adequacy in comparison to current standards

approach - the part of the roadway immediately before and after the bridge structure

approach pavement - an approach which has a cross section that is either the same as or slightly wider than the bridge deck width

approach slab - a reinforced concrete slab placed on the approach embankment adjacent to and usually resting upon the abutment back wall; the function of the approach slab is to carry wheel loads on the approaches directly to the abutment, thereby transitioning any approach roadway misalignment due to approach embankment settlement

appurtenance - an element that contributes to the general functionality of the bridge site (e.g., lighting, signing)

apron - a form of scour (erosion) protection consisting of timber, concrete, riprap, paving, or other construction material placed adjacent to abutments and piers to prevent undermining

arch - a curved structure element primarily in compression that transfers vertical loads through inclined reactions to its end supports

arch barrel - a single arch member that extends the width of the structure

arch rib - the main support element used in open spandrel arch construction; also known as arch ring

armor - a secondary steel member installed to protect a vulnerable part of another member, e.g., steel angles placed over the edges of a joint; also scour protection such as rip rap

as-built plans - plans made after the construction of a project, showing all field changes to the final design plans (i.e., showing how the bridge was actually built)

asphalt - a brown to black bituminous substance that is found in natural beds and is also obtained as a residue in petroleum refining and that consists chiefly of hydrocarbons; an asphaltic composition used for pavements and as a waterproof cement

ASTM - American Society for Testing and Materials

auger - a drill with a spiral channel used for boring

axial - in line with the longitudinal axis of a member

axle load - the load borne by one axle of a traffic vehicle, a movable bridge, or other motive equipment or device and transmitted through a wheel or wheels

B

back - see EXTRADOS

backfill - material, usually soil or coarse aggregate, used to fill the unoccupied portion of a substructure excavation such as behind an abutment stem and backwall

backstay - cable or chain attached at the top of a tower and extending to and secured upon the anchorage to resist overturning stresses exerted upon the tower by a suspended span

backwall - the topmost portion of an abutment above the elevation of the bridge seat, functioning primarily as a retaining wall with a live load surcharge; it may serve also as a support for the extreme end of the bridge deck and the approach slab

backwater - the back up of water in a stream due to a downstream obstruction or constriction

bank - sloped sides of a waterway channel or approach roadway, short for embankment

bascule bridge - a bridge over a waterway with one or two leaves which rotate from a horizontal to a near-vertical position, providing unlimited overhead clearance

base course - a layer of compacted material found just below the wearing course that supports the pavement

base metal - the surface metal of a steel element to be incorporated in a welded joint; also known as structure metal, parent metal

base plate - steel plate, whether cast, rolled or forged, connected to a column, bearing or other member to transmit and distribute its load to the substructure

batten plate - a plate with two or more fasteners at each end used in lieu of lacing to tie together the shapes comprising a built-up member

batter - the inclination of a surface in relation to a horizontal or a vertical plane; commonly designated on bridge detail plans as a ratio (e.g., 1:3, H:V); see RAKE

battered pile - a pile driven in an inclined position to resist horizontal forces as well as vertical forces

bay - the area of a bridge floor system between adjacent multi-beams or between adjacent floor beams

beam - a linear structural member designed to span from one support to another and support vertical loads

bearing - a support element transferring loads from superstructure to substructure while permitting limited movement capability

bearing capacity - the load per unit area which a structural material, rock, or soil can safely carry

bearing failure - crushing of material under extreme compressive load

bearing pile - a pile which provides support through the tip (or lower end) of the pile

bearing plate - a steel plate, which transfers loads from the superstructure to the substructure

bearing pressure - the bearing load divided by the area to which it is applied

bearing seat - a prepared horizontal surface at or near the top of a substructure unit upon which the bearings are placed

bearing stiffener - a vertical web stiffener at the bearing location

bearing stress - see BEARING PRESSURE

bedding - the soil or backfill material used to support pipe culverts

bedrock - the undisturbed rock layer below the surface soil

bench mark - an established reference point with known elevation and coordinates, used to document dimensions, elevations or position movement

bending moment - the internal force within a beam resulting from transverse loading

bent - a substructure unit made up of two or more column or column-like members connected at their top-most ends by a cap, strut, or other member holding them in their correct positions

berm - the line that defines the location where the top surface of an approach embankment or causeway is intersected by the surface of the side slope

beveled washer - a wedge-shaped washer used in connections incorporating members with sloped flange legs, e.g., channels and S-beams

bitumen - a black sticky mixture of hydrocarbons obtained from natural deposits or from distilling petroleum; tar

bituminous concrete - a mixture of aggregate and liquid asphalt or bitumen, which is compacted into a dense mass

blanket - a streambed protection against scour placed adjacent to abutments and piers

BMS - Bridge Management System

bolt - a mechanical fastener with machine threads at one end to receive a nut, and an integral head at the other end

bolster - a block-like member used to support a bearing on top of a pier cap or abutment bridge seat; see PEDESTAL

bond - in reinforced concrete, the grip of the concrete on the reinforcing bars, which prevents slippage of the bars relative to the concrete mass

bond stress - a term commonly applied in reinforced concrete construction to the stress developed by a force tending to produce movement or slippage at the interface between the concrete and the reinforcement bars

bowstring truss - a general term applied to a truss of any type having a polygonal arrangement of its top chord members conforming to or nearly conforming to the arrangement required for a parabolic truss; a truss with a curved top chord

box beam - a hollow structural beam with a square, rectangular, or trapezoidal cross-section that supports vertical loads and provides torsional rigidity

box culvert - a culvert of rectangular or square cross-section

box girder - a hollow, rectangular or trapezoidal shaped girder, a primary member along the longitudinal axis of the bridge, which provides good torsional rigidity

bracing - a system of secondary members that maintains the geometric configuration of primary members

bracket - a projecting support fixed upon two intersecting members to strengthen and provide rigidity to the connection

breastwall - the portion of an abutment between the wings and beneath the bridge seat; the breast wall supports the superstructure loads, and retains the approach fill; see STEM

bridge - a structure spanning and providing passage over a river, chasm, road, or similar obstacle

bridge deficiency - a defect in a bridge component or member that makes the bridge less capable or less desirable for use

bridge pad - the raised, leveled area upon which the pedestal, masonry plate or other corresponding element of the superstructure bears on the substructure; also called bridge seat bearing area

bridge seat - the top surface of an abutment or pier upon which the superstructure span is placed and supported; for an abutment it is the surface forming the support for the superstructure and from which the backwall rises; for a pier it is the entire top surface

bridge site - the position or location of a bridge and its surrounding area

bridging - a carpentry term applied to the cross-bracing fastened between timber beams to increase the rigidity of the floor construction, limit differential deflection and minimize the effects of impact and vibration

brittle fracture - the failure of a steel member occurring without warning, prior to plastic deformation

brush curb - a narrow curb, 9 inches or less in width, which prevents a vehicle from brushing against the railing or parapet

buckle - to fail by an inelastic change in alignment (deflection) as a result of compression in axial loaded members

buckle plate - an obsolete style of steel deck using dished steel plates as structural members

built-up member - a column or beam composed of plates and angles or other structural shapes united by bolting, riveting or welding to enhance section properties

bulb t-girder - a t-shaped concrete girder with a bulb shape at the bottom of the girder cross section

bulkhead - a retaining wall-like structure commonly composed of driven sheet piles or a barrier of wooden timbers or reinforced concrete members

buoyancy - upward pressure exerted by the fluid in which an object is immersed

butt joint - a joint between two pieces of metal that have been connected in the same plane

buttress - a bracket-like wall, of full or partial height, projecting from another wall; the buttress strengthens and stiffens the wall against overturning forces; all parts of a buttress act in compression

buttressed wall - a retaining wall designed with projecting buttresses to provide strength and stability

butt weld - a weld joining two plates or shapes end to end; also splice weld

C

cable - a tension member comprised of numerous individual steel wires or strands twisted and wrapped in such a fashion to form a rope of steel; see SUSPENSION BRIDGE

cable band - a steel casting with clamp bolts which fixes a floor system suspender cable to the catenary cable of a suspension bridge

cable-stayed bridge - a bridge in which the superstructure is directly supported by cables, or stays, passing over or attached to towers located at the main piers

caddisfly - a winged insect closely related to the moth and butterfly whose aquatic larvae seek shelter by digging small shallow holes into submerged timber elements

caisson - a rectangular or cylindrical chamber for keeping water or soft ground from flowing into an excavation

camber - the slightly arched or convex curvature provided in beams to compensate for dead load deflection; in general, a structure built with perfectly straight lines appears slightly sagged

cantilever - a structural member that has a free end projecting beyond a support; length of span overhanging the support

cantilever abutment - an abutment that resists lateral earth pressure through the opposing cantilever action of a vertical stem and horizontal footing

cantilever bridge - a general term applying to a bridge having a superstructure incorporating cantilever design

cantilever span - a superstructure span composed of two cantilever arms, or of a suspended span supported by one or two cantilever arms

cap - the topmost portion of a pier or a pile bent serving to distribute the loads upon the columns or piles and to hold them in their proper relative positions; see PIER CAP, PILE CAP

cap beam - the top member in a bent that ties together the supporting members

capstone - the topmost stone of a masonry pillar, column or other structure requiring the use of a single capping element

carbon steel - steel (iron with dissolved carbon) owing its properties principally to its carbon content; ordinary, unalloyed steel

cast-in-place (C.I.P.) - the act of placing and curing concrete within formwork to construct a concrete element in its final position

cast iron - relatively pure iron, smelted from iron ore, containing 1.8 to 4.5% free carbon and cast to shape

catch basin - a receptacle, commonly box shaped and fitted with a grided inlet and a pipe outlet drain, designed to collect the rainwater and floating debris from the roadway surface and retain the solid material so that it may be periodically removed

catchment area - see DRAINAGE AREA

catenary - the curve obtained by suspending a uniformly loaded rope or cable between two points

cathode - the negatively charged pole of a corrosion cell that accepts electrons and does not corrode

cathodic protection - a means of preventing metal from corroding by making it a cathode through the use of impressed direct current or by attaching a sacrificial anode

catwalk - a narrow walkway for access to some part of a structure

causeway - an elevated roadway crossing a body of water

cellular abutment - an abutment in which the space between wings, abutment stem, approach slab, and footings is hollow. Also known as a vaulted abutment

cement mortar - a mixture of sand and cement with enough water to make it plastic

cement paste - the plastic combination of cement and water that supplies the cementing action in concrete

centerline of bearings - a horizontal line that passes through the centers of the bearings, used in abutment/pier layout and beam erection

center of gravity - the point at which the entire mass of a body acts; the balancing point of an object

centroid - that point about which the static moment of all the elements of area is equal to zero

chain drag - a chain or a series of short medium weight chains attached to a T-shaped handle; used as a preliminary technique for sounding a large deck area for delamination

chamfer - an angled edge or corner, typically formed in concrete

channel - a waterway connecting two bodies of water or containing moving water; a rolled steel member having a C-shaped cross section

channel profile - a longitudinal section of a channel along its centerline

check - a crack in wood occurring parallel with the grain and through the rings of annual growth

cheek wall - see KNEE WALL

chipping hammer - hammer such as a geologist's pick or masonry hammer used to remove corrosion from steel members and to sound concrete for delamination; a welder's tool for cleaning slag from steel after welding

chloride - an ingredient in deicing agents that can damage concrete and steel bridge elements

chord - a generally horizontal member of a truss

circular arch - an arch in which the intrados surface has a constant radius

clearance - the unobstructed vertical or horizontal space provided between two objects

clear headroom - the vertical clearance beneath a bridge structure available for navigational use

clear span - the unobstructed space or distance between support elements of a bridge or bridge member

clip angle - see CONNECTION ANGLE

closed spandrel arch - a stone, brick or reinforced concrete arch span having spandrel walls to retain the spandrel fill or to support either entirely or in part the floor system of the structure when the spandrel is not filled

coarse aggregate - aggregate that stays on a sieve of 5 mm ($\frac{1}{4}$ " square opening

coating - a material that provides a continuous film over a surface in order to protect or seal it; a film formed by the material

coefficient of thermal expansion - the unit change in dimension produced in a material by a change of one degree in temperature

cofferdam - a temporary dam-like structure constructed around an excavation to exclude water; see SHEET PILE COFFERDAM

cold chisel - short bar with a sharp end used for cold-cutting soft metals when struck with a hammer

column - a general term applying to a vertical member resisting compressive stresses and having, in general, a considerable length in comparison with its transverse dimensions

column bent - a bent shaped pier that uses columns incorporated with a cap beam

compaction - the process by which a sufficient amount of energy (compressive pressure) is applied to soil or other material to increase its density

component - a general term reserved to define a bridge deck, superstructure or substructure

composite action - the contribution of a concrete deck to the moment resisting capacity of the superstructure beam when the superstructure beams are not the same material as the deck

composite construction - a method of construction whereby a cast-in-place concrete deck is mechanically attached to superstructure members by shear connectors

compression - a type of stress involving pressing together; tends to shorten a member; opposite of tension

compression failure - buckling, crushing, or collapse caused by compression stress

compression flange - the part of a beam that is compressed due to a bending moment

compression seal joint - a joint consisting of a neoprene elastic seal squeezed into the joint opening

concentrated load - a force applied over a small contact area; also known as point load

concrete - a stone-like mass made from a mixture of aggregates and cementing material, which is moldable prior to hardening; see BITUMINOUS CONCRETE and PORTLAND CEMENT CONCRETE

concrete beam - a structural member of reinforced concrete designed to carry bending loads

concrete pile - a pile constructed of reinforced concrete either precast and driven into the ground or cast-in-place in a hole bored into the ground

concrete tee team - "T" shaped section of reinforced concrete; cast-in-place monolithic deck and beam system

condition rating - a judgment of a bridge component condition in comparison to its original as-built condition

conductor - a material that is suitable for carrying electric current

connection angle - a piece of angle serving to connect two elements of a member or two members of a structure; also known as clip angle

consolidation - the time dependent change in volume of a soil mass under compressive load caused by water slowly escaping from the pores or voids of the soil

construction joint - a pair of adjacent surfaces in reinforced concrete where two pours have met, reinforcement steel extends through this joint

continuous beam - a general term applied to a beam that spans uninterrupted over one or more intermediate supports

continuous bridge - a bridge designed to extend without joints over one or more interior supports

continuous footing - a common footing that is underneath a wall, or columns

continuous span - spans designed to extend without joints over one or more intermediate supports

continuous truss - a truss without hinges having its chord and web members arranged to continue uninterrupted over one or more intermediate points of support

continuous weld - a weld extending throughout the entire length of a connection

contraction - the thermal action of the shrinking of an object when cooled; opposite of expansion

coping - a course of stone laid with a projection beyond the general surface of the masonry below it and forming the topmost portion of a wall; a course of stone capping the curved or V-shaped extremity of a pier, providing a transition to the pier head proper, when so used it is commonly termed the "starling coping," "nose coping," the "cutwater coping" or the "pier extension coping"

corbel - a piece constructed to project from the surface of a wall, column or other portion of a structure to serve as a support for another member

core - a cylindrical sample of concrete or timber removed from a bridge component for the purpose of destructive testing to determine the condition of the component

corrosion - the general disintegration of metal through oxidation

corrugated - an element with alternating ridges and valleys

counter - a truss web member that undergoes stress reversal and resists only live load tension; see WEB MEMBERS

counterfort - a bracket-like wall connecting a retaining wall stem to its footing on the side of the retained material to stabilize the wall against overturning; a counterfort, as opposed to a buttress, acts entirely in tension

counterforted abutment - an abutment that develops resistance to bending moment in the stem by use of counterforts. This permits the breast wall to be designed as a horizontal beam or slab spanning between counterforts, rather than as a vertical cantilever slab

counterforted wall - a retaining wall designed with projecting counterforts to provide strength and stability

counterweight - a weight which is used to balance the weight of a movable member; in bridge applications counterweights are used to balance a movable span so that it rotates or lifts with minimum resistance. Also sometimes used in continuous structures to prevent uplift

couplant - a viscous fluid material used with ultrasonic gages to enhance transmission of sound waves

couple - two forces that are equal in magnitude, opposite in direction, and parallel with respect to each other

coupon - a sample of steel taken from an element in order to test material properties

course - a horizontal layer of bricks or stone

cover - the clear thickness of concrete between a reinforcing bar and the surface of the concrete; the depth of backfill over the top of a pipe or culvert

covered bridge - an indefinite term applied to a wooden bridge having its roadway protected by a roof and enclosing sides

cover plate - a plate used in conjunction with a flange or other structural shapes to increase flange section properties in a beam, column, or similar member

crack - a break without complete separation of parts; a fissure

cracking (reflection) - visible cracks in an overlay indicating cracks in the concrete underneath

crack initiation - the beginning of a crack usually at some microscopic defect

crack propagation - the growth of a crack due to energy supplied by repeated stress cycles

creep - an inelastic deformation that occurs under a constant load, below the yield point, and increases with time

creosote - an oily liquid obtained by the distillation of coal or wood tar and used as a wood preservative

crib - a structure consisting of a foundation grillage combined with a superimposed framework providing compartments or coffer which are filled with gravel, concrete or other material satisfactory for supporting the structure to be placed thereon

cribbing - a construction consisting of wooden, metal or reinforced concrete units so assembled as to form an open cellular-like structure for supporting a superimposed load or for resisting horizontal or overturning forces acting against it.

cribwork - large timber cells that are submerged full of concrete to make an underwater foundation

cross - transverse bracings between two main longitudinal members; see DIAPHRAGM, BRACING

cross frame - steel elements placed in "X" shaped patterns to act as stiffeners between the main carrying superstructure members

cross girders - transverse girders, supported by bearings, which support longitudinal beams or girders

cross-section - the shape of an object cut transversely to its length

cross-sectional area - the area of a cross-section

crown - the highest point of the transverse cross section of a roadway, pipe or arch; also known as soffit or vertex

crown of roadway - the vertical dimension describing the total amount the surface is convexed or raised from gutter to centerline; this is sometimes termed the cross fall or cross slope of roadway

culvert - a drainage structure beneath an embankment (e.g., corrugated metal pipe, concrete box culvert)

curb - a low barrier at the side limit of the roadway used to guide the movement of vehicles

curb inlet - see SCUPPER

curtain wall - a term commonly applied to a thin wall between main columns designed to withstand only secondary loads. Also the wall portion of a buttress or counterfort abutment that spans between the buttresses or counterforts

curvature - the degree of curving of a line or surface

curved girder - a girder that is curved in the horizontal plane in order to adjust to the horizontal alignment of the bridge

cutoff wall - vertical wall at the end of an apron or slab to prevent scour undermining

cutwater - a sharp-edged structure, facing the water channel current, built around a bridge pier to protect it

from the flow of water and debris in the water

cyclic stress - stress that varies with the passage of live loads; see STRESS RANGE

D

dead load - a static load due to the weight of the structure itself

debris - material including floating wood, trash, suspended sediment or bed load moved by a flowing stream

deck - that portion of a bridge which provides direct support for vehicular and pedestrian traffic, supported by a superstructure

deck arch - an arch bridge with the deck above the top of the arch

deck bridge - a bridge in which the supporting members are all beneath the roadway

decking - bridge flooring installed in panels, e.g., timber planks

deck joint - a gap allowing for rotation or horizontal movement between two spans or an approach and a span

deficiency - see BRIDGE DEFICIENCY

deflection - elastic movement of a structural member under a load

deformation - distortion of a loaded structural member; may be elastic or inelastic

deformed bars - concrete reinforcement consisting of steel bars with projections or indentations (deformations) to increase the mechanical bond between the steel and concrete

degradation - general progressive lowering of a stream channel by scour

delamination - surface separation of concrete into layers; separation of glulam timber plies

design load - the force for which a structure is designed; the most severe combination of loads

deterioration - decline in quality over a period of time due to chemical or physical degradation

diagonal - a sloping structural member of a truss or bracing system

diagonal stay - a cable support in a suspension bridge extending diagonally from the tower to the roadway to add stiffness to the structure and diminish the deformations and undulations resulting from traffic service

diagonal tension - the tensile force due to horizontal and vertical shear in a beam

diaphragm - a transverse member placed within a member or superstructure system to distribute stresses and improves strength and rigidity; see BRACING

diaphragm wall - a wall built transversely to the longitudinal centerline of a spandrel arch serving to tie together and reinforce the spandrel walls, together with providing a support for the floor system in conjunction with the spandrel walls; also known as cross wall

differential settlement - uneven settlement of individual or independent elements of a substructure; tilting in the longitudinal or transverse direction due to deformation or loss of foundation material

dike - an earthen embankment constructed to retain or redirect water; when used in conjunction with a bridge, it prevents stream erosion and localized scour and/or so directs the stream current such that debris does not accumulate; see SPUR

discharge - the volume of fluid per unit of time flowing along a pipe or channel

displacement induced stress - stresses caused by differential deflection of adjacent parts

distributed load - a load uniformly applied along the length of an element or component of a bridge

ditch - a trough-like excavation made to collect water

diver - a specially trained individual who inspects the underwater portion of a bridge substructure and the surrounding channel

dolphin - a group of piles driven close together or a caisson placed to protect portions of a bridge exposed to possible damage by collision with river or marine traffic

double movable bridge - a bridge in which the clear span over the navigation channel is produced by joining the arms of two adjacent swing spans or the leaves of two adjacent bascule spans at or near the center of the navigable channel; see MOVABLE BRIDGE

dowel - a length of bar embedded in two parts of a structure to hold the parts in place and to transfer stress

drainage - a system designed to remove water from a structure

drainage area - an area in which surface run-off collects and from which it is carried by a drainage system; also known as catchment area

drain hole - hole in a box shaped member or a wall to provide means for the exit of accumulated water or other liquid; also known as drip hole; see WEEP HOLE

drain pipes - pipes that carry storm water

drawbridge - a general term applied to a bridge over a navigable body of water having a movable superstructure span of any type

drift bolt - a short length of metal bar used to connect and hold in position wooden members placed in contact; similar to a dowel

drift pin - tapered steel rod used by ironworkers to align bolt holes

drip notch - a recess cast on the underside of an overhang that prevents water from following the concrete surface onto the supporting beams

drop inlet - a type of inlet structure that conveys the water from a higher elevation to a lower outlet elevation smoothly without a free fall at the discharge

duct - the hollow space where a prestressing tendon is placed in a post-tensioned prestressed concrete girder

ductile - capable of being molded or shaped without breaking; plastic

ductile fracture - a fracture characterized by plastic deformation

ductility - the ability to withstand non-elastic deformation without rupture

dumbbell pier - a pier consisting of two cylindrical or rectangular shaped piers joined by an integral web

dummy member - truss member that carries no primary loads; may be included for bracing or for appearance

E

E - modulus of elasticity of a material; Young's modulus; the stiffness of a material

efflorescence - a deposit on concrete or brick caused by crystallization of carbonates brought to the surface by moisture in the masonry or concrete

elastic - capable of sustaining deformation without permanent loss of shape

elastic deformation - non-permanent deformation; when the stress is removed, the material returns to its original shape

elasticity - the property whereby a material changes its shape under the action of loads but recovers its original shape when the loads are removed

elastomer - a natural or synthetic rubber-like material

elastomeric pad - a synthetic rubber pad used in bearings that compresses under loads and accommodates horizontal movement by deforming

electrolyte - a medium of air, soil, or liquid carrying ionic current between two metal surfaces, the anode and the cathode

electrolytic cell - a device for producing electrolysis consisting of the electrolyte and the electrodes

electrolytic corrosion - corrosion of a metal associated with the flow of electric current in an electrolyte

elevation view - a drawing of the side view of a structure

elliptic arch - an arch in which the intrados surface is a full half of the surface of an elliptical cylinder; this terminology is sometimes incorrectly applied to a multicentered arch

elongation - the elastic or plastic extension of a member

embankment - a mound of earth constructed above the natural ground surface to carry a road or to prevent water from passing beyond desirable limits; also known as bank

end block - in a prestressed concrete I-beam, the widened beam web at the end to provide adequate anchorage bearing for the post tensioning steel and to resist high shear stresses; similarly, the solid end diaphragm of a box beam

end post - the end compression member of a truss, either vertical or inclined in position and extending from top chord to bottom chord

end section - a concrete or steel appurtenance attached to the end of a culvert for the purpose of hydraulic efficiency, embankment retention or anchorage

end span - a span adjacent to an abutment

epoxy - a synthetic resin which cures or hardens by chemical reaction between components which are mixed together shortly before use

epoxy coated reinforcement - reinforcement steel coated with epoxy; used to prevent corrosion

equilibrium - in statics, the condition in which the forces acting upon a body are such that no external effect (or movement) is produced

equivalent uniform load - a load having a constant intensity per unit of its length producing an effect equal to that of a live load consisting of vehicle axle or wheel concentrations spaced at varying distances

erosion - wearing away of soil by flowing water not associated with a channel; see SCOUR

expansion - an increase in size or volume

expansion bearing - a bearing designed to permit longitudinal or lateral movements resulting from temperature changes and superimposed loads with minimal transmission of horizontal force to the substructure; see BEARING

expansion dam - the part of an expansion joint serving as an end form for the placing of concrete at a joint; also applied to the expansion joint device itself; see EXPANSION JOINT

expansion joint - a joint designed to permit expansion and contraction movements produced by temperature changes, loadings or other forces

expansion rocker - a bearing device at the expansion end of a beam or truss that allows the longitudinal

movements resulting from temperature changes and superimposed loads through a tilting motion

expansion roller - a cylinder so mounted that by revolution it facilitates expansion, contraction or other movements resulting from temperature changes, loadings or other forces

expansion shoe - expansion bearing, generally of all metal construction

exterior girder - an outermost girder supporting the bridge floor

extrados - the curve defining the exterior (upper) surface of an arch; also known as back

eyebars - a member consisting of a rectangular bar with enlarged forged ends having holes for engaging connecting pins

F

failure - a condition at which a structure reaches a limit state such as cracking or deflection where it is no longer able to perform its usual function; collapse; fracture

falsework - a temporary wooden or metal framework built to support the weight of a structure during the period of its construction and until it becomes self-supporting

fascia - an outside, covering member designed on the basis of architectural effect rather than strength and rigidity, although its function may involve both

fascia girder - an exposed outermost girder of a span sometimes treated architecturally or otherwise to provide an attractive appearance

fatigue - the tendency of a member to fail at a stress below the yield point when subjected to repetitive loading

fatigue crack - any crack caused by repeated cyclic loading at a stress below the yield point

fatigue damage - member damage (crack formation) due to cyclic loading

fatigue life - the length of service of a member subject to fatigue, based on the number of cycles it can undergo

fender - a structure that acts as a buffer to protect the portions of a bridge exposed to floating debris and water-borne traffic from collision damage; sometimes called an ice guard in regions with ice floes

fender pier - a pier-like structure which performs the same service as a fender but is generally more substantially built; see GUARD PIER

field coat - a coat of paint applied after the structure is assembled and its joints completely connected; quite commonly a part of the field erection procedure; field painting

fill - material, usually earth, used to change the surface contour of an area, or to construct an embankment

filler - a piece used primarily to fill a space beneath a batten, splice plate, gusset, connection angle, stiffener or other element; also known as filler plate

filler metal - metal prepared in wire, rod, electrode or other form to be fused with the structure metal in the formation of a weld

filler plate - see FILLER

fillet - a curved portion forming a junction of two surfaces that would otherwise intersect at an angle

fillet weld - a weld of triangular or fillet shaped cross-section between two pieces at right angles

filling - see FILL

fine aggregate - sand or grit for concrete or mortar that passes a No. 4 sieve (4.75 mm)

finger dam - expansion joint in which the opening is spanned by meshing steel fingers or teeth

fish belly - a term applied to a girder or a truss having its bottom flange or its bottom chord constructed either haunched or bow-shaped with the convexity downward; see LENTICULAR TRUSS

fixed beam - a beam with a fixed end

fixed bearing - a bearing that allows only rotational movement; see BEARING

fixed bridge - a bridge having constant position, i.e., without provision for movement to create increased navigation clearance

fixed end - movement is restrained

fixed-ended arch - see VOUSOIR ARCH

fixed span - a superstructure span having its position practically immovable, as compared to a movable span

fixed support - a support that will allow rotation only, no longitudinal movement

flange - the (usually) horizontal parts of a rolled I-shaped beam or of a built-up girder extending transversely across the top and bottom of the web

flange angle - an angle used to form a flange element of a built-up girder, column, strut or similar member

floating bridge - see PONTOON BRIDGE

floating foundation - used to describe a soil-supported raft or mat foundation with low bearing pressures; sometimes applied to a "foundation raft" or "foundation grillage"

flood frequency - the average time interval in years in which a flow of a given magnitude will recur

flood plain - area adjacent to a stream or river subject to flooding

floor - see DECK

floorbeam - a primary horizontal member located transversely to the general bridge alignment

floor system - the complete framework of members supporting the bridge deck and the traffic loading

flow capacity - maximum flow rate that a channel, conduit, or culvert structure is hydraulically capable of carrying

flux - a material that protects the weld from oxidation during the fusion process

footbridge - a bridge designed and constructed to provide means of traverse for pedestrian traffic only; also known as pedestrian bridge

footing - the enlarged, lower portion of a substructure, which distributes the structure load either to the earth or to supporting piles; the most common footing is the concrete slab; footer is a colloquial term for footing

foot wall - see TOE WALL

force - an influence that tends to accelerate a body or to change its movement

forms - the molds that hold concrete in place while it is hardening; also known as form work, shuttering; see LAGGING, STAY-IN-PLACE FORMS

form work - see FORMS

foundation - the supporting material upon which the substructure portion of a bridge is placed

foundation excavation - the excavation made to accommodate a footing for a structure; also known as foundation pit

foundation failure - failure of a foundation by differential settlement or by shear failure of the soil

foundation grillage - a construction consisting of steel, timber, or concrete members placed in layers; each layer is perpendicular to those above and below it and the members within a layer are generally parallel, producing a crib or grid-like effect. Grillages are usually placed under very heavy concentrated loads

foundation load - the load resulting from traffic, superstructure, substructure, approach embankment, approach causeway, or other incidental load increment imposed upon a given foundation area

foundation pile - see PILE

foundation pit - see FOUNDATION EXCAVATION

foundation seal - a mass of concrete placed underwater within a cofferdam for the base portion of structure to close or seal the cofferdam against incoming water; see TREMIE

fracture - see BRITTLE FRACTURE

fracture critical member - a member in tension or with a tension element whose failure would probably cause a portion of or the entire bridge to collapse

frame - a structure which transmits bending moments from the horizontal beam member through rigid joints to vertical or inclined supporting members

framing - the arrangement and connection of the component members of a bridge superstructure

free end - movement is not restrained

friction pile - a pile that provides support through friction resistance between the pile and the surrounding earth along the lateral surface of the pile

friction roller - a roller placed between members intended to facilitate change in their relative positions by reducing the frictional resistance to translation movement

frost heave - the upward movement of, or force exerted by, soil due to freezing of retained moisture

frost line - the depth to which soil may be frozen

G

gabion - rock filled wire baskets used to retain earth and provide erosion control

galvanic action - electrical current between two unlike metals

galvanize - to coat with zinc

gauge - the distance between parallel lines of rails, rivet holes, etc; a measure of thickness of sheet metal or wire; also known as gage

geometry - shape or form; relationship between lines or points

girder - a horizontal flexural member that is the main or primary support for a structure; any large beam, especially if built up

girder bridge - a bridge whose superstructure consists of two or more girders supporting a separate floor system as differentiated from a multi-beam bridge or a slab bridge

girder span - a span in which the major longitudinal supporting members are girders

glue laminated - a member created by gluing together two or more pieces of lumber

grade - the fall or rise per unit horizontal length; see GRADIENT

grade crossing - a term applicable to an intersection of two highways, two railroads or a railroad and a highway at a common grade or elevation; now commonly accepted as meaning the last of these combinations

grade intersection - the location where two roadway slopes meet in profile; to provide a smooth transition from one to the other they are connected by a vertical curve and the resulting profile is a sag or a crest

grade separation - roadways crossing each other at different elevations; see OVERPASS, UNDERPASS

gradient - the rate of inclination of the roadway and/or sidewalk surface(s) from the horizontal, applying to a bridge and its approaches; it is commonly expressed as a percentage relation (ratio) of horizontal to vertical dimensions

gravity abutment - a thick abutment that resists horizontal earth pressure through its own dead weight

gravity wall - a retaining wall that is prevented from overturning or sliding by its own dead weight

grid flooring - a steel floor system comprising a lattice pattern that may or may not be filled with concrete

grillage - assembly of parallel beams, usually steel or concrete, placed side by side, often in layers with alternating directions; see FOUNDATION GRILLAGE

groin - a wall built out from a river bank to check scour

grout - mortar having a sufficient water content to render it free-flowing, used for filling (grouting) the joints in masonry, for fixing anchor bolts and for filling cored spaces; usually a thin mix of cement, water and sometimes sand or admixtures

grouting - the process of filling in voids with grout

guard pier - a pier-like structure built to protect a swing span in its open position from collision with passing vessels or water-borne debris; may be equipped with a rest pier upon which the swing span in its open position may be latched; see FENDER PIER

guardrail - a safety feature element intended to redirect an errant vehicle

guide rail - see GUARDRAIL

gunite - the process of blowing Portland cement mortar or concrete onto a surface using compressed air

gusset plate - a plate that connects the members of a structure and holds them in correct position at a joint

gutter - a paved ditch; area adjacent to a roadway curb used for drainage

guy - a cable member used to anchor a structure in a desired position

H

H Loading - a combination of loads used to represent a two-axle truck developed by AASHTO

hairline cracks - very narrow cracks that form in the surface of concrete due to tension caused by loading

hammer - hand tool used for sounding and surface inspection

hammerhead pier - a pier with a single cylindrical or rectangular shaft and a relatively long, transverse cap; also known as a tee pier or cantilever pier

hand hole - hole provided in component plate of built-up box section to permit access to the interior for construction and maintenance purposes

hand rail - commonly applies only to sidewalk railing presenting a latticed, barred, balustered or other open web construction

hands-on access - close enough to the member or component so that it can be touched with the hands and inspected visually

hanger - a tension member serving to suspend an attached member; allows for expansion between a cantilevered and suspended span

haunch - an increase in the depth of a member usually at points of support; the outside areas of a pipe between the spring line and the bottom of the pipe

haunched girder - a horizontal beam whose cross sectional depth varies along its length

H-beam - a rolled steel member having an H-shaped cross-section (flange width equals beam depth) commonly used for piling; also H-pile

head - a measure of water pressure expressed in terms of an equivalent weight or pressure exerted by a column of water; the height of the equivalent column of water is the head

head loss - the loss of energy between two points along the path of a flowing fluid due to fluid friction; reported in feet of head

headwall - a concrete structure at the ends of a culvert to retain the embankment slopes, anchor the culvert, and prevent undercutting

headwater - the source or the upstream waters of a stream

heat treatment - any of a number of various operations involving controlled heating and cooling that are used to impart specific properties to metals; examples are tempering, quenching, and annealing

heave - the upward motion of soil caused by outside forces such as excavation, pile driving, moisture or soil expansion; see FROST HEAVE

heel - the portion of a footing behind the stem

helical - having the form of a spiral

high carbon steel - carbon steel containing 0.5 to 1.5% dissolved carbon

high strength bolt - bolt and nut made of high strength steel, usually A325 or A490

hinge - a point in a structure at which a member is free to rotate

hinged joint - a joint constructed with a pin, cylinder segment, spherical segment or other device permitting rotational movement

honeycomb - an area in concrete where mortar has separated and left spaces between the coarse aggregate, usually caused by improper vibration during concrete construction

horizontal alignment - a roadway's centerline or baseline alignment in the horizontal plane

horizontal curve - a roadway baseline or centerline alignment defined by a radius in the horizontal plane

Howe truss - a truss of the parallel chord type with a web system composed of vertical (tension) rods at the panel points with an X pattern of diagonals

HS Loading - a combination of loads developed by AASHTO used to represent a truck and trailer

hybrid girder - a girder whose flanges and web are made from steel of different grades

hydraulics - the mechanics of fluids

hydrology - study of the accumulation and flow of water from watershed areas

hydroplaning - loss of contact between a tire and the roadway surface when the tire planes or glides on a film of water

I

I-beam - a structural member with a cross-sectional shape similar to the capital letter "I"

ice guard - see FENDER

impact - A factor that describes the effect on live load due to dynamic and vibratory effects of a moving load; in bridge design, a load based on a percentage of live load to include dynamic and vibratory effects; in fracture mechanics, a rapidly applied load, such as a collision or explosion

incomplete fusion - a weld flaw where the weld metal has not combined metallurgically with the base metal

indeterminate stress - stress in a structural member which cannot be calculated directly; it is computed by the iterative application of mathematical equations, usually with an electronic computer; indeterminate stresses arise in continuous span and frame type structures

individual column footing - footing supporting one column

inelastic compression - compression beyond the yield point

inlet - an opening in the floor of a bridge leading to a drain; roadway drainage structure which collects surface water and transfers it to pipes

inspection frequency - the frequency with which the bridge is inspected -- normally every two years

integral abutment - an abutment cast monolithically with the end diaphragm of the deck; such abutments usually encase the ends of the deck beams and are pile supported

integral deck - a deck which is monolithic with the superstructure; concrete tee beam bridges have integral decks

intercepting ditch - a ditch constructed to prevent surface water from flowing in contact with the toe of an embankment or causeway or down the slope of a cut

interior girder - any girder between exterior or fascia girders

interior span - a span of which both supports are intermediate substructure units

intermittent weld - a noncontinuous weld commonly composed of a series of short welds separated by spaces of equal length

intrados - the curve defining the interior (lower) surface of the arch; also known as soffit

inventory item - data contained in the structure file pertaining to bridge identification, structure type and material, age and service, geometric data, navigational data, classification, load rating and posting, proposed improvements, and inspections

inventory rating - the capacity of a bridge to withstand loads under normal service conditions based on 55% of yield strength

invert elevation - the bottom or lowest point of the internal surface of the transverse cross section of a pipe or culvert

iron - a metallic element used in cast iron, wrought iron and steel

isotropic - having the same material properties in all directions, e.g., steel

J

jack arch - a deck support system comprised of a brick or concrete arch springing from the bottom flanges of adjacent rolled steel beams

jacking - the lifting of elements using a type of jack (e.g., hydraulic), sometimes acts as a temporary support system

jack stringer - the outermost stringer supporting the bridge floor in a panel or bay

jacket - a protective shell surrounding a pile made of fabric, concrete or other material

jersey barrier - a concrete barrier with sloping front face that was developed by the New Jersey Department of Transportation

joint - in masonry, the space between individual stones or bricks; in concrete, a division in continuity of the concrete; in a truss, point at which members of a truss are joined

K

keeper plate - a plate, which is connected to a sole plate, designed to prohibit a beam from becoming dislodged from the bearing

key - a raised portion of concrete on one face of a joint that fits into a depression on the adjacent face

keystone - the symmetrically shaped, wedge-like stone located in a head ring course at the crown of an arch; the final stone placed, thereby closing the arch

king-post - the vertical member in a "king-post" type truss; also known as king rod

king-post truss - two triangular panels with a common center vertical; the simplest of triangular system trusses

kip - a kilo pound (1000 lb.); convenient unit for structural calculations

knee brace - a short member engaging at its ends two other members that are joined to form a right angle or a near-right angle to strengthen and stiffen the connecting joint

knee wall - a return of the abutment backwall at its ends to enclose the bridge seat on three of its sides; also called cheek wall

knife edge - a condition in which corrosion of a steel member has caused a sharp edge

knuckle - an appliance forming a part of the anchorage of a suspension bridge main suspension member permitting movement of the anchorage chain

K-truss - a truss having a web system wherein the diagonal members intersect the vertical members at or near

the mid-height; the assembly in each panel forms a letter "K"

L

L-abutment - a cantilever abutment with the stem flush with the toe of the footing, forming an "L" in cross section

laced column - a riveted, steel built-up column of usually four angles or two channels tied together laterally with lacing

lacing - small flat plates, usually with one rivet at each end, used to tie individual sections of built up members; see LATTICE

lagging - horizontal members spanning between piles to form a wall; forms used to produce curved surfaces; see FORMS

lamellar tear - incipient cracking parallel to the face of a steel member

laminated timber - timber planks glued together face to face to form a larger member; see GLUE LAMINATED

lane loading - a design loading which represents a line of trucks crossing over a bridge

lap joint - a joint between two members in which the end of one member overlaps the end of the other

lateral - a member placed approximately perpendicular to a primary member

lateral bracing - the bracing assemblage engaging a member perpendicular to the plane of the member; intended to resist transverse movement and deformation; also keeps primary parallel elements in truss bridges and girder bridges aligned; see BRACING

lattice - a crisscross assemblage of diagonal bars, channels, or angles on a truss; also known as latticing, lacing

lattice truss - in general, a truss having its web members inclined but more commonly the term is applied to a truss having two or more web systems composed entirely of diagonal members at any interval and crossing each other without reference to vertical members

leaching - the action of removing substances from a material by passing water through it

lead line - a weighted cord incrementally marked, used to determine the depth of a body of water; also known as sounding line

leaf - the movable portion of a bascule bridge that forms the span of the structure

lenticular truss - a truss having parabolic top and bottom chords curved in opposite directions with their ends meeting at a common joint; also known as a fish belly truss

levee - an embankment built to prevent flooding of low-lying land

leveling course - a layer of bituminous concrete placed to smooth an irregular surface

light-weight concrete - concrete of less than standard unit weight; may be no-fines concrete, aerated concrete, or concrete made with lightweight aggregate

link - a hanger plate in a pin and hanger assembly whose shape is similar to an eyebar, e.g., the head (at the pinhole) is wider than the shank

link and roller - a movable bridge element consisting of a hinged strut-like link fitted with a roller at its bottom end, supported upon a shoe plate or pedestal and operated by a thrust strut serving to force it into a vertical position and to withdraw it therefrom; when installed at each outermost end of the girders or the trusses of a swing span their major function is to lift them to an extent that their camber or droop will be removed and the arms rendered free to act as simple spans; when the links are withdrawn to an inclined position fixed by the operating mechanism the span is free to be moved to an open position

live load - a temporary dynamic load such as vehicular traffic that is applied to a structure; also accompanied by vibration or movement affecting its intensity

load - a force carried by a structure component

load factor design - a design method used by AASHTO, based on limit states of material and arbitrarily increased loads

load indicating washer - a washer with small projections on one side, which compress as the bolt is tightened; gives a direct indication of the bolt tension that has been achieved

load rating - calculation of the amount of load a bridge can carry based on actual member size and condition

load and resistance factor design (LRFD) - design method used by AASHTO, based on limit states of material with increased loads and reduced member capacity based on statistical probabilities

local buckling - localized buckling of a beam's plate element, can lead to failure of member

longitudinal bracing - bracing that runs lengthwise with a bridge and provides resistance against longitudinal movement and deformation of transverse members

loss of prestress - loss of prestressing force due to a variety of factors, including shrinkage and creep of the concrete, creep of the prestressing tendons, and loss of bond

low-carbon steel - steel with 0.04 to 0.25% dissolved carbon; also called mild steel

lower chord - the bottom horizontal member of a truss

luminaire - a lighting fixture

M

macadam - roadway pavement made with crushed stone aggregate, of coarse open gradation, compacted in place; asphaltic macadam included asphalt as a binder

main beam - a horizontal structural member which supports the span and bears directly on a column or wall

maintenance - basic repairs performed on a facility to keep it at an adequate level of service

maintenance and protection of traffic - the management of vehicular and pedestrian traffic through a construction zone to ensure the safety of the public and the construction workforce; MPT; TRAFFIC PROTECTION

marine borers - mollusks and crustaceans that live in water and destroy wood by digesting it

masonry - that portion of a structure composed of stone, brick or concrete block placed in courses and usually cemented with mortar

masonry cement - Portland cement and lime used to make mortar for masonry construction

masonry plate - a steel plate placed on the substructure to support a superstructure bearing and to distribute the load to the masonry beneath

mattress - a flexible scour protection blanket composed of interconnected timber, gabions, or concrete units.

meander - a twisting, winding action from side to side; characterizes the serpentine curvature of a narrow, slow flowing stream in a wide flood plain

median - separation between opposing lanes of highway traffic; also known as median strip

member - an individual angle, beam, plate, or built component piece intended ultimately to become an integral part of an assembled frame or structure

metal corrosion - oxidation of metal by electro-galvanic action involving an electrolyte (moisture), an anode (the metallic surface where oxidation occurs), a cathode (the metallic surface that accepts electrons and does not corrode), and a conductor (the metal piece itself)

midspan - a reference point half-way between the supports of a beam or span

mild steel - steel containing from 0.04 to 0.25% dissolved carbon; see LOW CARBON STEEL

military loading - a loading pattern used to simulate heavy military vehicles passing over a bridge

mill scale - dense iron oxide on iron or steel that forms on the surface of metal that has been forged or hot worked

modular joint - a bridge joint designed to handle large movements consisting of an assembly of several strip

or compression seals

moisture content - the amount of water in a material expressed as a percent by weight

moment - the couple effect of forces about a given point; see BENDING MOMENT

monolithic - forming a single mass without joints

mortar - a paste of portland cement, sand, and water laid between bricks, stones or blocks

movable bridge - a bridge having one or more spans capable of being raised, turned, lifted, or slid from its normal service location to provide a clear navigation passage; see BASCULE BRIDGE, VERTICAL LIFT BRIDGE, PONTOON BRIDGE, RETRACTILE DRAW BRIDGE, ROLLING LIFT BRIDGE, and SWING BRIDGE

movable span - a general term applied to a superstructure span designed to be swung, lifted or otherwise moved longitudinally, horizontally or vertically, usually to provide increased navigational clearance

moving load - a live load which is moving, for example, vehicular traffic

MPT - see MAINTENANCE AND PROTECTION OF TRAFFIC

MSE - mechanically stabilized earth; see REINFORCED EARTH

multi-centered arch - an arch in which the intrados surface is outlined by two or more arcs symmetrically arranged and having different radii that intersect tangentially

N

nail laminated - a laminated member produced by nailing two or more pieces of timber together face to face

NBIS - National Bridge Inspection Standards, first established in 1971 to set national policy regarding bridge inspection frequency, inspector qualifications, report formats, and inspection and rating procedures

NCHRP - National Cooperative Highway Research Program

NDE - nondestructive evaluation

NDT - nondestructive testing; any testing method of checking structural quality of materials that does not damage them

necking - the elongation and contraction in area that occurs when a ductile material is stressed

negative bending - bending of a member that causes tension in the surface adjacent to the load, e.g., moment at interior supports of a span or at the joints of a frame

negative moment - bending moment in a member such that tension stresses are produced in the top portions

of the member; typically occurs in continuous beams and spans over the intermediate supports

neoprene - a synthetic rubber-like material used in expansion joints and elastomeric bearings

neutral axis - the internal axis of a member in bending along which the strain is zero; on one side of the neutral axis the fibers are in tension, on the other side the fibers are in compression

nose - a projection acting as a cut water on the upstream end of a pier; see STARLING

notch effect - stress concentration caused by an abrupt discontinuity or change in section

O

offset - a horizontal distance measured at right angles to a survey line to locate a point off the line

on center - a description of a typical dimension between the centers of the objects being measured

open spandrel arch - a bridge that has open spaces between the deck and the arch members allowing "open" visibility through the bridge

open spandrel ribbed arch - a structure in which two or more comparatively narrow arch rings, called ribs, function in the place of an arch barrel; the ribs are rigidly secured in position by arch rib struts located at intervals along the length of the arch; the arch ribs carry a column type open spandrel construction which supports the floor system and its loads

operating rating - the capacity of a bridge to withstand loads based on 75% of yield strength

operator's house - the building containing control devices required for opening and closing a movable bridge span

orthotropic - having different properties in two or more directions at right angles to each other (e.g., wood); see ANISOTROPY

outlet - in hydraulics, the discharge end of drains, sewers, or culverts

out-of-plane distortion - distortion of a member in a plane other than that which the member was designed to resist

overlay - see WEARING SURFACE

overload - a weight greater than the structure is designed to carry

overpass - bridge over a roadway or railroad

overturning - tipping over; rotational movement

oxidation - the chemical breakdown of a substance due to its reaction with oxygen from the air

oxidized steel - rust

P

pack - a steel plate inserted between two others to fill a gap and fit them tightly together; also known as packing; fill; filler plate

pack rust - rust forming between adjacent steel surfaces in contact which tends to force the surfaces apart due to the increase in material volume

paddleboard - striped, paddle-shaped signs or boards placed on the roadside in front of a narrow bridge as a warning of reduced roadway width

panel - the portion of a truss span between adjacent points of intersection of web and chord members

panel point - the point of intersection of primary web and chord members of a truss

parabolic arch - an arch in which the intrados surface is a segment of a symmetrical parabolic surface (suited to concrete arches)

parabolic truss - a polygonal truss having its top chord and end post vertices coincident with the arc of a parabola, its bottom chord straight and its web system either triangular or quadrangular; also known as a parabolic arched truss

parapet - a low wall along the outmost edge of the roadway of a bridge to protect vehicles and pedestrians

pedestal - concrete or built-up metal member constructed on top of a bridge seat for the purpose of providing a specific bearing seat elevation

pedestal pier - one or more piers built in block-like form that may be connected by an integrally built web between them; when composed of a single, wide block-like form, it is called a wall or solid pier

pedestrian bridge - see FOOT BRIDGE

penetration - when applied to creosoted lumber, the depth to which the surface wood is permeated by the creosote oil; when applied to pile driving; the depth a pile tip is driven into the ground

physical testing - the testing of bridge members in the field or laboratory

pier - a substructure unit that supports the spans of a multi-span superstructure at an intermediate location between its abutments

pier cap - the topmost horizontal portion of a pier that distributes loads from the superstructure to the vertical pier elements

pile - a shaft-like linear member which carries loads to underlying rock or soil strata

pile bent - a row of driven or placed piles extending above the ground surface supporting a pile cap; see BENT

pile bridge - a bridge carried on piles or pile bents

pile cap - a slab or beam which acts to secure the piles in position laterally and provides a bridge seat to receive and distribute superstructure loads

pile foundation - a foundation supported by piles in sufficient number and to a depth adequate to develop the bearing resistance required to support the substructure load

pile pier - see PILE BENT

piling - collective term applied to group of piles in a construction; see PILE, SHEET PILES

pin - a cylindrical bar used to connect elements of a structure

pin-connected truss - a general term applied to a truss of any type having its chord and web members connected at each panel point by a single pin

pin and hanger - a hinged connection detail designed to allow for expansion and rotation between a cantilevered and suspended span at a point between supports.

pin joint - a joint in a truss or other frame in which the members are assembled upon a single cylindrical pin

pin packing - arrangement of truss members on a pin at a pinned joint

pin plate - a plate rigidly attached upon the end of a member to develop the desired bearing upon a pin or pin-like bearing, and secure additional strength and rigidity in the member; doubler plate

pintle - a relatively small steel pin engaging the rocker of an expansion bearing, in a sole plate or masonry plate, thereby preventing sliding of the rocker

pipe - a hollow cylinder used for the conveyance of water, gas, steam etc.

pipng - removal of fine particles from within a soil mass by flowing water

plain concrete - concrete with no structural reinforcement except, possibly, light steel to reduce shrinkage and temperature cracking

plan and profile - a drawing that shows both the roadway plan view and profile view in the same scale; see PLAN VIEW, PROFILE

plan view - drawing that represents the top view of the road or a structure

plastic deformation - permanent deformation of material beyond the elastic range

plate - a flat sheet of metal which is relatively thick; see SHEET STEEL

plate girder - a large I-shaped beam composed of a solid web plate with flange plates attached to the web plate by flange angles or fillet welds

plug weld - a weld joining two members produced by depositing weld metal within holes cut through one or more of the members; also known as slot weld

plumb bob - a weight hanging on a cord used to provide a true vertical reference

plumb line - a true vertical reference line established using a plumb bob

pneumatic caisson - an underwater caisson in which the working chamber is kept free of water by compressed air at a pressure nearly equal to the water pressure outside it

pointing - the compacting of the mortar into the outermost portion of a joint and the troweling of its exposed surface to secure water tightness or desired architectural effect; replacing deteriorated mortar

ponding - accumulation of water

pontoon bridge - a bridge supported by floating on pontoons moored to the riverbed; a portion may be removable to facilitate navigation

pony truss - a through truss without top chord lateral bracing

pop-out - conical fragment broken out of a concrete surface by pressure from reactive aggregate particles

portable bridge - a bridge that may be readily erected for a temporary communication-transport service and disassembled and reassembled at another location

portal - the clear unobstructed space of a through truss bridge forming the entrance to the structure

portal bracing - a system of sway bracing placed in the plane of the end posts of the trusses

portland cement - a fine dry powder made by grinding limestone clinker made by heating limestone in a kiln; this material reacts chemically with water to produce a solid mass

portland cement concrete - a mixture of aggregate, portland cement, water, and usually chemical admixtures

positive moment - a force applied over a distance that causes compression in the top fiber of a beam and tension in the bottom fiber

post - a member resisting compressive stresses, located vertical to the bottom chord of a truss and common to two truss panels; sometimes used synonymously for vertical; see COLUMN

posting - a limiting dimension, speed, or loading indicating larger dimensions, higher speeds, or greater loads cannot be safely taken by the bridge

post-stressing - see POSTTENSIONING

posttensioning - a method of prestressing concrete in which the tendons are stressed after the concrete has been cast and hardens

pot bearing - a bearing type that allows for multi-dimensional rotation by using a piston supported on an elastomer contained on a cylinder ("pot"), or spherical bearing element

pot holes - irregular shaped, disintegrated areas of bridge deck or roadway pavement caused by the failure of the surface material

Pratt truss - a truss with parallel chords and a web system composed of vertical posts with diagonal ties inclined outward and upward from the bottom chord panel points toward the ends of the truss; also known as N-truss

precast concrete - concrete members that are cast and cured before being placed into their final positions on a construction site

prestressed concrete - concrete with strands, tendons, or bars that are stressed before the live load is applied

prestressing - applying forces to a structure to deform it in such a way that it will withstand its working loads more effectively; see POSTTENSIONING, PRETENSIONING

pretensioning - a method of prestressing concrete in which the strands are stressed before the concrete is placed; strands are released after the concrete has hardened, inducing internal compression into the concrete

primary member - a member designed to resist flexure and distribute primary live loads and dead loads

priming coat - the first coat of paint applied to the metal or other material of a bridge; also known as base coat, or primer

probing - investigating the location and condition of submerged foundation material using a rod or shaft of appropriate length; checking the surface condition of a timber member for decay using a pointed tool, e.g., an ice pick

profile - a section cut vertically along the center line of a roadway or waterway to show the original and final ground levels

programmed repair - those repairs that may be performed in a scheduled program

protective system - a system used to protect bridges from environmental forces that cause steel and concrete to deteriorate and timber to decay, typically a coating system

PS&E - Plans, Specifications, and Estimate; the final submission of the designers to the owner

punching shear - shear stress in a slab due to the application of a concentrated load

Q

quality assurance - an independent evaluation of a product or activity (e.g., an inspection) to establish that a predescribed level of quality has been met

quality control - checks necessary to maintain a uniform level of quality

queen-post truss - a parallel chord type of truss having three panels with the top chord occupying only the length of the center panel

R

railing - a fence-like construction built at the outermost edge of the roadway or the sidewalk portion of a bridge to protect pedestrians and vehicles; see HANDRAIL

rake - an angle of inclination of a surface in relation to a vertical plane; also known as batter

ramp - an inclined traffic-way leading from one elevation to another

range of stress - the algebraic difference between the minimum and maximum stresses in a member

raveling - the consistent loss of aggregate from a pavement resulting in a poor riding surface

reaction - the resistance of a support to a load

rebar - see REINFORCING BAR

redundancy - a structural condition where there are more elements of support than are necessary for stability so that, if a structural member fails, the remaining element can sustain the load

redundant member - a member in a bridge which renders it a statically indeterminate structure; the structure would be stable without the redundant member whose primary purpose is to reduce the stresses carried by the determinate structure

rehabilitation - significant repair work to a structure

reinforced concrete - concrete with steel reinforcing bars embedded in it to supply increased tensile strength and durability

reinforced concrete pipe - pipe manufactured of concrete reinforced with steel bars or welded wire fabric

Reinforced Earth - proprietary retaining structure made of earth and steel strips connected to concrete facing; the steel strips are embedded in backfill and interlock with the facing; see MSE

reinforcement - rods or mesh embedded in concrete to strengthen it

reinforcing bar - a steel bar, plain or with a deformed surface, which bonds to the concrete and supplies tensile strength to the concrete

relaxation - a decrease in stress caused by creep

residual stress - a stress that is trapped in a member after it is formed into its final shape

resistivity of soil - an electrical measurement in ohm-cm that estimates the corrosion activity potential of a given soil

resurfacing - a layer of wearing surface material that is put over the approach or deck surface in order to create a more uniform riding surface

Retained Earth - proprietary retaining structure made of weld wire fabric strips connected to concrete facing; see MSE

retaining wall - a structure designed to restrain and hold back a mass of earth

retractile draw bridge - a bridge with a superstructure designed to move horizontally, either longitudinally or diagonally, from "closed" to "open" position, the portion acting in cantilever being counterweighted by that supported on rollers; also known as traverse draw bridge

rib - curved structural member supporting a curved shape or panel

rigger - an individual who erects and maintains scaffolding or other access equipment such as that used for bridge inspection

rigid frame - a structural frame in which bending moment is transferred between horizontal and vertical or inclined members by joints

rigid frame bridge - a bridge with moment resisting joints between the horizontal portion of the superstructure and vertical or inclined legs

rigid frame pier - a pier with two or more columns and a horizontal beam on top constructed monolithically to act like a frame

rip-rap - stones, blocks of concrete or other objects placed upon river and stream beds and banks, lake, tidal or other shores to prevent scour by water flow or wave action

rivet - a one-piece metal fastener held in place by forged heads at each end

riveted joint - a joint in which the assembled members are fastened by rivets

roadway - the portion of the road intended for the use of vehicular traffic

roadway shoulder - drivable area immediately adjoining the traveled roadway

rocker bearing - a bridge support that accommodates expansion and contraction of the superstructure through a tilting action

rocker bent - a bent hinged or otherwise articulated at one or both ends to provide the longitudinal movements resulting from temperature changes and superimposed loads

rolled shape - forms of rolled steel having "I", "H", "C", "Z" or other cross sectional shapes

rolled-steel section - any hot-rolled steel section including wide flange shapes, channels, angles, etc.

roller - a steel cylinder intended to provide longitudinal movements by rolling contact

roller bearing - a single roller or a group of rollers so installed as to permit longitudinal movement of a structure

roller nest - a group of steel cylinders used to facilitate the longitudinal movements resulting from temperature changes and superimposed loads

rolling lift bridge - a bridge of bascule type devised to roll backward and forward upon supporting girders when operated through an "open and closed" cycle

rubble - irregularly shaped pieces of stone in the undressed condition obtained from a quarry and varying in size

runoff - the quantity of precipitation that flows from a catchment area past a given point over a certain period

S

sacrificial anode - the anode in a cathodic protection system

sacrificial coating - a coating over the base material to provide protection to the base material; examples include galvanizing on steel and aluclading on aluminum

sacrificial protection - see CATHODIC PROTECTION

sacrificial thickness - additional material thickness provided for extra service life of a member in an aggressive environment

saddle - a member located upon the topmost portion of the tower of a suspension bridge which acts as a bearing surface for the catenary cable passing over it

safe load - the maximum load that a structure can support with an appropriate factor of safety

safety belt - a belt worn in conjunction with a safety line to prevent falling a long distance when working at heights; no longer acceptable as fall protection under OSHA rules

safety curb - a curb between 9 inches and 24 inches wide serving as a limited use refuge or walkway for pedestrians crossing a bridge

safety factor - the difference between the ultimate strength of a member and the maximum load it is expected to carry

safety harness - harness with shoulder, leg, and waist straps of approved OSHA design used as personal fall protection in conjunction with appropriate lanyards and tie off devices

sag - to sink or bend downward due to weight or pressure

scab - a plank bolted over the joint between two timber members to hold them in correct alignment and strengthen the joint; a short piece of I-beam or other structural shape attached to the flange or web of a metal pile to increase its resistance to penetration; also known as scab piece

scaling - the gradual disintegration of a concrete surface due to the failure of the cement paste caused by chemical attack or freeze/thaw cycles

scour - removal of a streambed or bank area by stream flow

scour protection - protection of submerged material by steel sheet piling, rip rap, concrete lining, or combination thereof

scuba - self-contained underwater breathing apparatus; a portable breathing device for free swimming divers

scupper - an opening in the deck of a bridge to provide means for water accumulated upon the roadway surface to drain

seam weld - a weld joining the edges of two members placed in contact; in general, it is not a stress-carrying weld

seat - a base on which an object or member is placed

seat angle - a piece of angle attached to the side of a member to provide support for a connecting member either temporarily during its erection or permanently; also known as a shelf angle

secondary member - a member that does not carry calculated live loads; bracing members

section loss - loss of a member's cross sectional area usually by corrosion or decay

section view - an internal representation of a structure element as if a slice was made through the element

seepage - the slow movement of water through a material

segmental - constructed of individual pieces or segments which are collectively joined to form the whole

segmental arch - a circular arch in which the intrados is less than a semi-circle

segregation - in concrete construction, the separation of large aggregate from the paste during placement

seismic - a term referring to earthquakes (e.g., seismic forces)

semi-stub abutment - cantilever abutment founded part way up the slope, intermediate in size between a full height abutment and a stub abutment

service load design - AASHTO's description for Working Stress Design

settlement - the movement of substructure elements due to changes in the soil properties

shear - the load acting across a beam near its support

shear connectors - devices that extend from the top flange of a beam and are embedded in the above concrete slab, forcing the beam and the concrete to act as a single unit

shear spiral - a coil-shaped component welded to the top flange of a beam, as a shear connector

shear stress - the shear force per unit of cross-sectional area; also referred to as diagonal tensile stress

shear stud - a type of shear connector in the form of a rod with a head that is attached to a beam with an automatic stud-welding gun

sheet pile cofferdam - a wall-like barrier composed of driven piling constructed to surround the area to be occupied by a structure and permit dewatering of the enclosure so that the excavation may be performed in the open air

sheet piles - flattened Z-shaped interlocking piles driven into the ground to keep earth or water out of an excavation or to protect an embankment

sheet piling - a general or collective term used to describe a number of sheet piles installed to form a crib, cofferdam, bulkhead, etc.; also known as sheeting

sheet steel - steel in the form of a relatively thin sheet or plate; for flat rolled steel, specific thicknesses vs. widths are classified by AISI as bar, strip, sheet or plate

shelf angle - see SEAT ANGLE

shim - a thin plate inserted between two elements to fix their relative position and to transmit bearing stress

shoe - a steel or iron member, usually a casting or weldment, beneath the superstructure bearing that transmits and distributes loads to the substructure bearing area

shop - a factory or workshop

shop drawings - detailed drawings developed from the more general design drawings used in the manufacture or fabrication of bridge components

shoring - a strut or prop placed against or beneath a structure to restrain movement; temporary soil retaining structure

shoulder abutment - a cantilever abutment extending from the grade line of the road below to that of the road overhead, usually set just off the shoulder; see FULL HEIGHT ABUTMENT

shoulder area - see ROADWAY SHOULDER

shrinkage – a reduction in volume caused by moisture loss in concrete or timber while drying

sidewalk - the portion of the bridge floor area serving pedestrian traffic only

sidewalk bracket - frame attached to and projecting from the outside of a girder to serve as a support for the sidewalk stringers, floor and railing or parapet

sight distance - the length of roadway ahead that is easily visible to the driver; required sight distances are defined by AASHTO's "A Policy on Geometric Design of Highways and Streets"

silt - very finely divided siliceous or other hard rock material removed from its mother rock through erosive action rather than chemical decomposition

simple span - beam or truss with two unrestraining supports near its ends

S-I-P forms - see STAY-IN-PLACE FORMS, FORMS

skew angle - the angle produced when the longitudinal members of a bridge are not perpendicular to the substructure; the skew angle is the acute angle between the alignment of the bridge and a line perpendicular to the centerline of the substructure units

skewback - the inclined support at each end of an arch

skewback shoe - the member transmitting the thrust of an arch to the skewback course or cushion course of an abutment or piers; also known as skewback pedestal

slab - a wide beam, usually of reinforced concrete, which supports load by flexure

slab bridge - a bridge having a superstructure composed of a reinforced concrete slab constructed either as a single unit or as a series of narrow slabs placed parallel with the roadway alignment and spanning the space between the supporting substructure units

slide - movement on a slope because of an increase in load or a removal of support at the toe; also known as landslide

slip form - to form concrete by advancing a mold

slope - the inclination of a surface expressed as a ratio of one unit of rise or fall for so many horizontal units

slope protection - a thin surfacing of stone, concrete or other material deposited upon a sloped surface to

prevent its disintegration by rain, wind or other erosive action; also known as slope pavement

slot weld - see PLUG WELD

slump - a measurement taken to determine the stiffness of concrete; the measurement is the loss in height after a cone-shaped mold is lifted

soffit - underside of a bridge deck; also see INTRADOS

soldier beam - a steel pile driven into the earth with its projecting butt end used as a cantilever beam

soldier pile wall - a series of soldier beams supporting horizontal lagging to retain an excavated surface; commonly used in limited right-of-way applications

soil interaction structure - a subsurface structure that incorporates both the strength properties of a flexible structure and the support properties of the soil surrounding the structure

sole plate - a plate attached to the bottom flange of a beam that distributes the reaction of the bearing to the beam

solid sawn beam – a section of tree cut to the desired size at a saw mill

sounding - determining the depth of water by an echo-sounder or lead line; tapping a surface to detect delaminations (concrete) or decay (timber)

spall - depression in concrete caused by a separation of a portion of the surface concrete, revealing a fracture parallel with or slightly inclined to the surface

span - the distance between the supports of a beam; the distance between the faces of the substructure elements; the complete superstructure of a single span bridge or a corresponding integral unit of a multiple span structure; see CLEAR SPAN

spandrel - the space bounded by the arch extrados and the horizontal member above it

spandrel column - a column constructed on the rib of an arch span and serving as a support for the deck construction of an open spandrel arch; see OPEN SPANDREL ARCH

spandrel fill - the fill material placed within the spandrel space of a closed spandrel arch

spandrel tie - a wall or a beam-like member connecting the spandrel walls of an arch and securing them against bulging and other deformation; in stone masonry arches the spandrel tie walls served to some extent as counterforts

spandrel wall - a wall built on the extrados of an arch filling the space below the deck; see TIE WALLS

specifications - a detailed description of requirements, materials, tolerances, etc., for construction which are not shown on the drawings; also known as specs

spider - inspection access equipment consisting of a bucket or basket which moves vertically on wire rope, driven by an electric or compressed air motor

spillway - a channel used to carry water away from the top of a slope to an adjoining outlet

splice - a structural joint between members to extend their effective length

spread footing - a foundation, usually a reinforced concrete slab, which distributes load to the earth or rock below the structure

spring line - the horizontal line along the face of an abutment or pier at which the intrados of an arch begins

spur - a projecting jetty-like construction placed adjacent to an abutment or embankment to prevent scour

stage - inspection access equipment consisting of a flat platform supported by horizontal wire-rope cables; the stage is then slid along the cables to the desired position; a stage is typically 20 inches wide, with a variety of lengths available

staged construction - construction performed in phases, usually to permit the flow of traffic through the site

statics - the study of forces and bodies at rest

station - 100 feet (U.S. customary); 100 meters (metric)

stationing - a system of measuring distance along a baseline

stay-in-place forms - a corrugated metal sheet for forming deck concrete that will remain in place after the concrete has set; the forms do not contribute to deck structural capacity after the deck has cured; see FORMS, S.I.P FORMS

stay plate - a tie plate or diagonal brace to prevent movement

steel - an alloy of iron, carbon, and various other elements

stem - the vertical wall portion of an abutment retaining wall, or solid pier; see BREASTWALL

stiffener - a small member attached to another member to transfer stress and to prevent buckling

stiffening girder - a girder incorporated in a suspension bridge to distribute the traffic loads uniformly among the suspenders and reduce local deflections

stiffening truss - a truss incorporated in a suspension bridge to distribute the traffic loads uniformly among the suspenders and reduce local deflections

stirrup - U-shaped bar used as a connection device in timber and metal bridges; U-shaped bar placed in concrete to resist diagonal tension (shear) stresses

stone masonry - the portion of a structure composed of stone, generally placed in courses with mortar

straight abutment - an abutment whose stem and wings are in the same plane or whose stem is included within a length of retaining wall

strain - the change in length of a body produced by the application of external forces, measured in units of length; this is the proportional relation of the amount of change in length divided by the original length

strand - a number of wires grouped together usually by twisting

strengthening - adding to the capacity of a structural member

stress - the force acting across a unit area in a solid material

stress concentration - local increases in stress caused by a sudden change of cross section in a member

stress range - the variation in stress at a point with the passage of live load, from initial dead load value to the maximum additional live load value and back

stress raiser - a detail that causes stress concentration

stress reversal - change of stress type from tension (+) to compression (−) or vice versa

stress sheet - a drawing showing all computed stresses resulting from the application of a system of loads together with the design composition of the individual members resulting from the application of assumed unit stresses for the material to be used in the structure

stress-laminated timber – consists of multiple planks mechanically clamped together to perform as one unit

stringer - a longitudinal beam spanning between transverse floorbeams and supporting a bridge deck

strip seal joint - a joint using a relatively thin neoprene seal fitted into the joint opening

structural analysis - engineering computation to determine the carrying capacity of a structure

structural member - an individual piece, such as a beam or strut, which is an integral part of a structure

structural redundancy - the ability of an interior continuous span to resist total collapse by cantilever action in the event of a fracture

structural shapes - the various types of rolled iron and steel having flat, round, angle, channel, "I", "H", "Z" and other cross-sectional shapes adapted to heavy construction

structural stability - the ability of a structure to maintain its normal configuration, not collapse or tip in any way, under existing and expected loads

structural tee - a tee-shaped rolled member formed by cutting a wide flange longitudinally along the centerline of web

structure - something, such as a bridge, that is designed and built to sustain a load

strut - a member acting to resist axial compressive stress; usually a secondary member

stub abutment - an abutment within the topmost portion of an embankment or slope having a relatively small vertical height and usually pile supported; stub abutments may also be founded on spread footings

subbase - a layer of material placed between the base course and the subgrade within a flexible pavement structure

subgrade - natural earth below the roadway pavement structure

sub-panel - a truss panel divided into two parts by an intermediate web member, generally a subdiagonal or a hanger

substructure - the abutments and piers built to support the span of a bridge superstructure

superelevation - the difference in elevation between the inside and outside edges of a roadway in a horizontal curve; required to counteract the effects of centrifugal force

superimposed dead load - dead load that is applied to a compositely designed bridge after the concrete deck has cured; for example, the weight of parapets or railings placed after the concrete deck has cured

superstructure - the entire portion of a bridge structure that primarily receives and supports traffic loads and in turn transfers these loads to the bridge substructure

surface corrosion - rust that has not yet caused measurable section loss

suspended span - a simple span supported from the free ends of cantilevers

suspender - a vertical wire cable, metal rod, or bar connecting the catenary cable of a suspension bridge or an arch rib to the bridge floor system, transferring loads from the deck to the main members

suspension bridge - a bridge in which the floor system is supported by catenary cables that are supported upon towers and are anchored at their extreme ends

suspension cable - a catenary cable which is one of the main members upon which the floor system of a suspension bridge is supported; a cable spanning between towers

swale - a drainage ditch with moderately sloping sides

sway anchorage - a guy, stay cable or chain attached to the floor system of a suspension bridge and anchored upon an abutment or pier to increase the resistance of the suspension span to lateral movement; also known as sway cable

sway bracing - diagonal brace located at the top of a through truss, transverse to the truss and usually in a vertical plane, to resist transverse horizontal forces

sway frame - a complete panel or frame of sway bracing

swedged anchor bolt - anchor bolt with deformations to increase bond in concrete; see ANCHOR BOLT

swing span bridge - a movable bridge in which the span rotates in a horizontal plane on a pivot pier, to permit passage of marine traffic

T

tack welds - small welds used to hold member elements in place during fabrication or erection

tail water - water ponded below the outlet of a waterway, thereby reducing the amount of flow through the waterway; see HEADWATER

tape measure - a long, flexible strip of metal or fabric marked at regular intervals for measuring

tee beam - a rolled steel section shaped like a "T"; reinforced concrete beam shaped like the letter "T"

temperature steel - reinforcement in a concrete member to prevent cracks due to stresses caused by temperature changes

temporary bridge - a structure built for emergency or interim use, intended to be removed in a relatively short time

tendon - a prestressing cable, strand, or bar

tensile force - a force caused by pulling at the ends of a member; see TENSION

tensile strength - the maximum tensile stress at which a material fails

tension - stress that tends to pull apart material

thermal movement - contraction and expansion of a structure due to a change in temperature

three-hinged arch - an arch that is hinged at each support and at the crown

through arch - an arch bridge in which the deck passes between the arches

through girder bridge - normally a two-girder bridge where the deck is between the supporting girders

tie - a member carrying tension

tie plate - relatively short, flat member carrying tension forces across a transverse member; for example, the plate connecting a floor beam cantilever to the main floor beam on the opposite side of a longitudinal girder; see STAY PLATE

tie rod - a rod-like member in a frame functioning to transmit tensile stress; also known as tie bar

tie walls - one of the walls built at intervals above an arch ring connecting and supporting the spandrel walls; any wall designed to serve as a restraining member to prevent bulging and distortion of two other walls connected thereby; see DIAPHRAGM WALL

timber - wood suitable for construction purposes

toe - the front portion of a footing from the intersection of the front face of the wall or abutment to the front edge of the footing; the line where the side slope of an embankment meets the existing ground

toe of slope - the location defined by the intersection of the embankment with the surface existing at a lower elevation; also known as toe

toe wall - a relatively low retaining wall placed near the "toe-of-slope" location of an embankment to protect against scour or to prevent the accumulation of stream debris; also known as footwall

ton - a unit of weight equal to 2,000 pounds

torque - the angular force causing rotation

torque wrench - a hand or power tool used to turn a nut on a bolt that can be adjusted to deliver a predetermined amount of torque

torsion - twisting about the longitudinal axis of a member

torsional rigidity - a beam's capacity to resist a twisting force along the longitudinal axis

tower - a pier or frame supporting the catenary cables of a suspension bridge

traffic control - modification of normal traffic patterns by signs, cones, flagmen, etc.

transducer - a device that converts one form of energy into another form, usually electrical into mechanical or the reverse; the part of ultrasonic testing device which transmits and receives sound waves

transverse bracing - the bracing assemblage engaging the columns of bents and towers in planes transverse to the bridge alignment that resists the transverse forces tending to produce lateral movement and deformation of the columns

transverse girder - see CROSS GIRDER

travel way - the roadway

tremie - a piece of construction equipment (e.g., pipe or funnel) used to place concrete underwater

trestle - a bridge structure consisting of spans supported on braced towers or frame bents

truck loading - a combination of loads used to simulate a single truck passing over a bridge

truss - a jointed structure made up of individual members primarily carrying axial loads arranged and connected in triangular panels

truss bridge - a bridge having a pair of trusses for a superstructure

trussed beam - a beam stiffened to reduce its deflection by a steel tie-rod that is held at a short distance from the beam by struts

truss panel - see PANEL

tubular sections - structural steel tubes, rectangular, square or circular; also known as hollow sections

tubular truss - a truss whose chords and struts are composed of pipes or cylindrical tubes

tunnel - an underground passage, open to daylight at both ends

turnbuckle - a long, cylindrical, internally threaded nut with opposite hand threads at either end used to connect the elements of adjustable rod and bar members

two-hinged arch - a rigid frame that may be arch-shaped or rectangular with hinges at both supports

U

U-bolt - a bar bent in the shape of the letter "U" and fitted with threads and nuts at its ends

ultimate strength - the highest stress that a material can withstand before breaking

ultrasonic thickness gage - an instrument used to measure the thickness of a steel element using a probe which emits and receives sound waves

ultrasonic testing - nondestructive testing of a material's integrity using sound waves

underpass - the lowermost feature of a grade separated crossing; see OVERPASS

uniform load - a load of constant magnitude along the length of a member

unit stress - the force per unit of surface or cross-sectional area

uplift - a negative reaction or a force tending to lift a beam, truss, pile, or any other bridge element upwards

upper chord - the top longitudinal member of a truss

V

vertical - describes the axis of a bridge perpendicular to the underpass surface

vertical alignment - a roadway's centerline or baseline alignment in the vertical plane

vertical clearance - the distance between the structure and the underpass

vertical curve - a sag or crest in the profile of a roadway, usually in the form of a parabola, to transition between grades

vertical lift bridge - a bridge in which the span moves up and down while remaining parallel to the roadway

viaduct - a series of spans carried on piers at short intervals

vibration - the act of vibrating concrete to compact it

Vierendeel truss - a truss with only chords and verticals joined with rigid connections designed to transfer moment

voided slab - a precast concrete deck unit cast with cylindrical voids to reduce dead load

voids - an empty or unfilled space in concrete

Voussoir - one of the truncated wedge-shaped stones composing a ring course in a stone arch; also known as ring stone

voussoir arch - an arrangement of wedge shaped blocks set to form an arched bridge

W

wale, waler - horizontal bracing running along the inside walls of a sheeted pit or cofferdam

Warren truss - a triangular truss consisting of sloping members between the top and bottom chords and no verticals; members form the letter W

washer - a small metal ring used beneath the nut or the head of a bolt to distribute the load or reduce galling during tightening

water/cement ratio - the weight of water divided by the weight of portland cement in concrete; this ratio is a major factor in the strength of concrete

waterproofing membrane - an impervious layer placed between the wearing surface and the concrete deck, used to protect the deck from water and corrosive chemicals that could damage it

waterway opening - the available width for the passage of water beneath a bridge

wearing surface - the topmost layer of material applied upon a roadway to receive the traffic loads and to resist the resulting disintegrating action; also known as wearing course

web - the portion of a beam located between and connected to the flanges; the stem of a dumbbell type pier

web crippling - damage caused by high compressive stresses resulting from concentrated loads

web members - the intermediate members of a truss, not including the end posts, usually vertical or inclined

web plate - the plate forming the web element of a plate girder, built-up beam or column

web stiffener - a small member welded to a beam web to prevent buckling of the web

weep hole - a hole in a concrete retaining wall to provide drainage of the water in the retained soil

weld - a joint between pieces of metal at faces that have been made plastic and caused to flow together by heat or pressure

weldability - the degree to which steel can be welded without using special techniques, such as pre-heating

welded bridge structure - a structure whose metal elements are connected by welds

welded joint - a joint in which the assembled elements and members are connected by welds

welding - the process of making a welded joint

weld layer - a single thickness of weld metal composed of beads (runs) laid in contact to form a pad weld or a portion of a weld made up of superimposed beads

weld metal - fused filler metal added to the fused structure metal to produce a welded joint or a weld layer

weld penetration - the depth beneath the original surface to which the structure metal has been fused in the making of a fusion weld; see PENETRATION

weld sequence - the order of succession required for making the welds of a built-up piece or the joints of a structure, to minimize distortion and residual stresses

weld toe - particularly in a fillet weld, the thin end of the taper furthest from the center of the weld cross section

wheel guard - a raised curb along the outside edge of traffic lanes to safeguard constructions outside the roadway limit from collision with vehicles

wheel load - the load carried by and transmitted to the supporting structure by one wheel of a traffic vehicle, a movable bridge, or other motive equipment or device; see AXLE LOAD

weep hole - a hole in a concrete element (abutment backwall or retaining wall) used to drain water from behind the element; any small hole installed for drainage

Whipple truss - a double-intersecting through Pratt truss where the diagonals extend across two panels

wide flange - a rolled I-shaped member having flange plates of rectangular cross section, differentiated from an S-beam (American Standard) in that the flanges are not tapered

wind bracing - the bracing systems that function to resist the stresses induced by wind forces

wind lock - a lateral restraining device found on steel girder and truss bridges

wingwall - the retaining wall extension of an abutment intended to restrain and hold in place the side slope material of an approach roadway embankment

wire mesh reinforcement - a mesh made of steel wires welded together at their intersections used to reinforce concrete; welded wire fabric

wire rope - steel cable of multiple strands which are composed of steel wires twisted together

working stress - the unit stress in a member under service or design load

working stress design - a method of design using the yield stress of a material and a factor of safety that determine the maximum allowable stresses

wrought iron - cast iron that has been mechanically worked to remove slag and undissolved carbon

wythe - a single layer of brick or stone in the thickness direction

X

X-ray testing - nondestructive testing technique used for detecting internal flaws by passing X-rays through a material to film or other detector

Y

yield - permanent deformation (permanent set) which a metal piece takes when it is stressed beyond the elastic limit

yield point - see YIELD STRESS

yield stress - the stress at which noticeable, suddenly increased deformation occurs under slowly increasing load

Z

zee - steel member shaped like a modified "Z" in cross section

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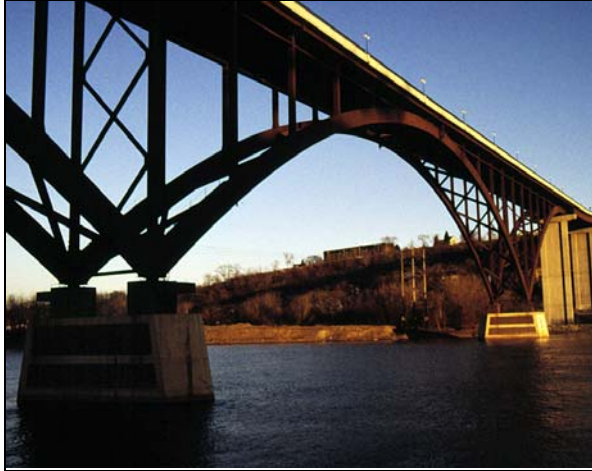
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Documentation and Evaluation

Solution Manual

Topic 5.1 – Timber Decks

Deck documentation (notes and sketch)

Total Quantity

**Total deck quantity = 16' W x 26' L = 416 SF or
5 m W x 8m L = 40 m²**

Inspection notes:

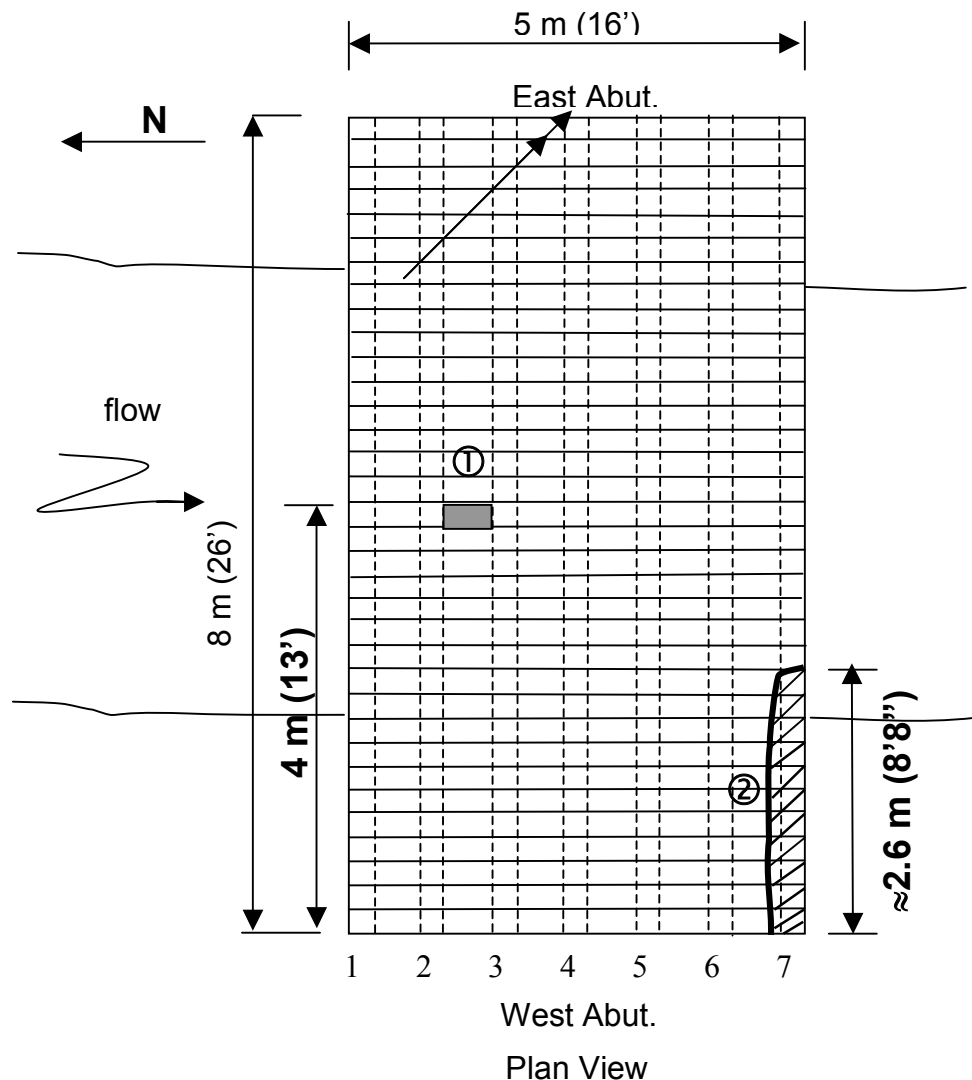
Timber plank deck with top of planks weathered and underside sound. 1 plank partially failed. ≈ 1/3 of planks @ connection to fascia beams loose, warped & rotted @ ends @ southwest corner of deck.

Check List

- ✓ Member Description
- ✓ Defect Locations
- ✓ Defect Description /Severity
- ✓ Defect Dimensions
- ✓ Defect Quantity (if required)

① Partial plank failure, 762 mm (30") long. (see Photo 3).

② Approx 11 planks loose; end 102 mm (4") rotted. (see Photo 4)



Member **TIMBER DECK**

Rating Exercise

Use the photos, field conditions, and dimensions given on pages 5.1.13 – 5.1.14. Rate the subject timber deck.

NBI Component Rating Method:

Circle the rating for this deck and explain why this rating was chosen (rating reasoning).

Deck Condition Rating = 9 8 7 **6** 5 4 3 2 1 0

Deck is in “satisfactory” condition structurally. Numerous loose planks and rotted plank ends are minor deteriorations. Partially failed plank beam isolated case.

Area provided for notes or calculations:

| Element | Total Quantity | Unit | Quantities in Condition States | | | | |
|-----------------------|--------------------------|------|--------------------------------|---|---|---|---|
| | | | 1 | 2 | 3 | 4 | 5 |
| 31 Timber Deck (Bare) | CoRe Elements | | | | | | |
| | 1 (40 m²) (416 SF) | EA | | 1 | | | |
| | | | | | | | |

Topic 5.2 – Concrete Decks

Deck documentation exercise

Total Quantity:

**Total deck quantity = 62' W x 30' L = 1,860 SF or
19 m W x 9 m L = 171 m²**

Inspection notes:

CIP concrete deck (bare) with HL to 3 mm (1/8") transverse and longitudinal cracks on surface in 2 SB lanes only. Underside of SB lanes have transverse & longitudinal cracks w/ efflorescence. Large spall 760 mm x 3960 mm (2'6" x 13') under median near south abutment w/ exposed rebar w/ minor section loss.

Check List

✓ Member
Description

✓ Defect Locations

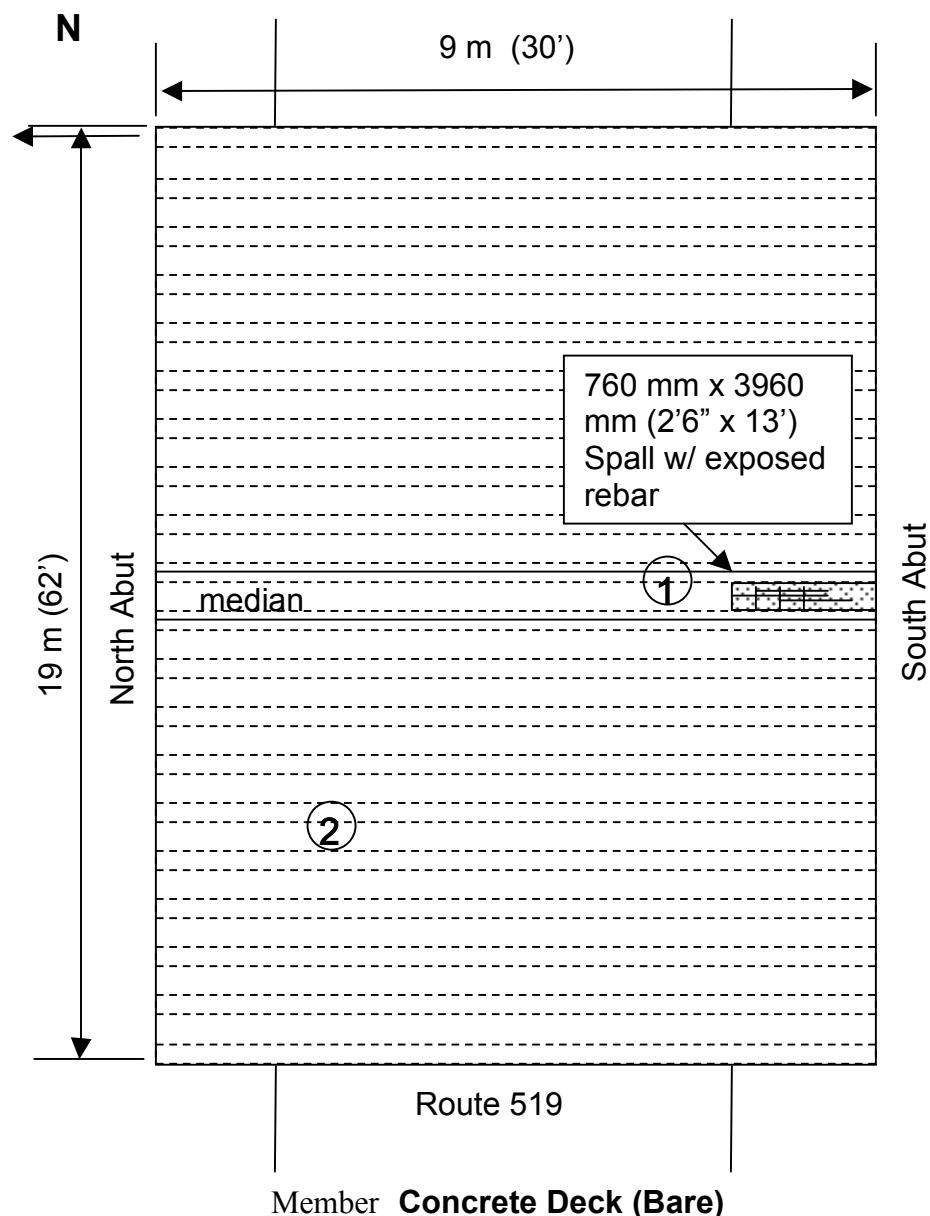
✓ Defect
Description
/Severity

✓ Defect
Dimensions

✓ Defect Quantity
(if required)

① Spall with
exposed rebars w/
minor section loss
(see Photos 6 & 7)

② Hairline to
medium longitudinal
& transverse cracks
in SB lanes top and
bottom (see Photos
3, 4 & 5)



Rating Exercise

Use the photos, field conditions, and dimensions given on pages 5.2.20 – 5.2.22. Rate the subject concrete deck.

NBI Component Rating Method:

Circle the rating for this deck and explain why this rating was chosen (rating reasoning).

Deck Condition Rating = 9 8 7 6 **5** 4 3 2 1 0

Deck is in “fair” condition structurally. The transverse and longitudinal cracks are typical over one-half of the span. Efflorescence was observed. One large spall was found with minor section loss on rebar (spall was 1.7% of deck underside area).

Area provided for notes or calculations:

$$2.5' \times 13' / 1860 \text{ SF} = 1.7\%$$

| Element | Total | Unit | Quantities in Condition States | | | | |
|-----------------------|-----------------------|------|--------------------------------|---|---|---|---|
| | Quantity | | 1 | 2 | 3 | 4 | 5 |
| 12 Concrete (Bare) | Core Elements | | | | | | |
| | 1 (1860 SF) 172 m² | EA | 1 | | | | |
| | | | | | | | |

| | | | | | | | |
|--|-----------------------|--|--|--|--|--|--|
| | <i>Other Elements</i> | | | | | | |
| | | | | | | | |
| | | | | | | | |

| | | | | | | | |
|----------------------------------|--------------------|----|--|--|---|---|--|
| 358 Deck Cracking | <i>Smart Flags</i> | | | | | | |
| | 1 | EA | | | 1 | | |
| 359 Soffit Under Surface of Deck | 1 | EA | | | | 1 | |

Topic 5.3 – Steel Decks

Deck documentation (notes and sketch)

Total Quantity

**Total deck quantity = 7 m W x 9 m L = 63 m² or
24' W x 30' L = 720 SF**

Inspection notes:

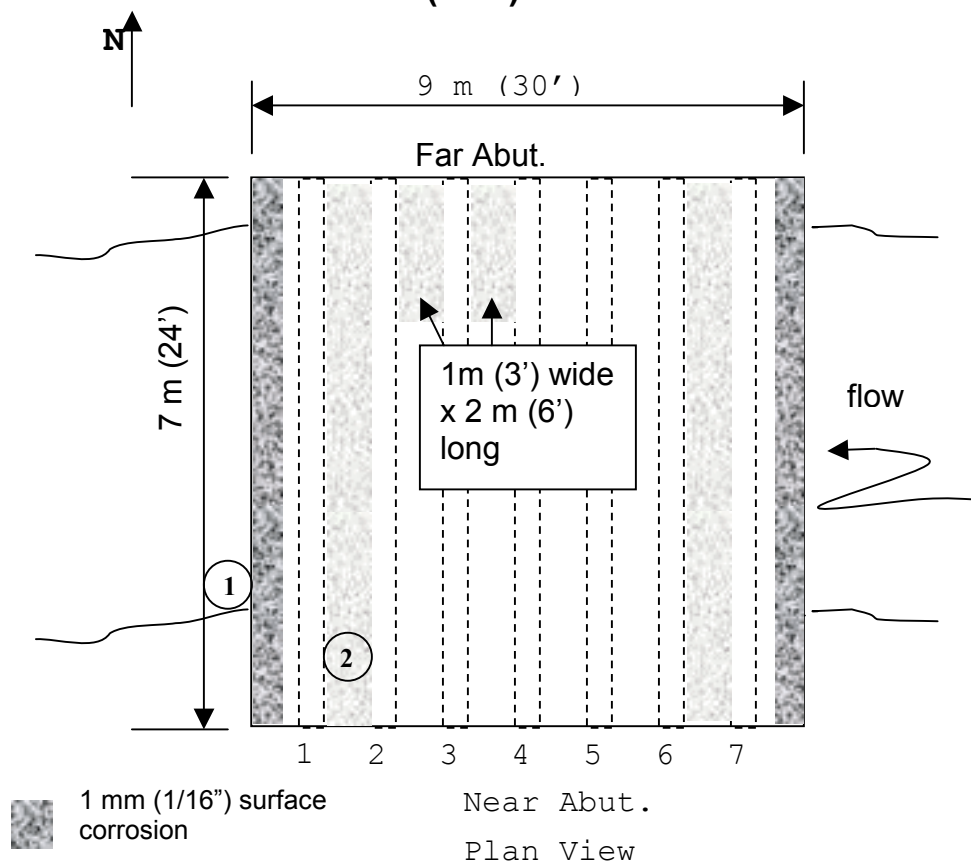
Bituminous ws w/ few scattered areas of longitudinal and transverse cracks to 1 mm (1/16") wide & no coverage @ shoulders 610 mm (2') wide x full length. Exposed portions of water tables 1 mm (1/16") surface corrosion typ. Steel pans in fascia areas heavily corroded w/ areas of 100% section loss. Similar condition between beams 2 & 3 and beams 3 & 4 @ FAB. Bearing bars in fascia bays & between beams 2 thru 4 @ FAB exhibit 3 mm (1/8") section loss.

Check List

- ✓ Member Description
- ✓ Defect Locations
- ✓ Defect Description /Severity
- ✓ Defect Dimensions
- ✓ Defect Quantity (if required)

① Exposed deck along shoulders 2' wide x full length w/ surface corrosion (see Photo 1)

② Steel pans w/ up to 100% section loss & 3 mm (1/8") section loss to primary bearing bars (see Photos 3 & 4)



Member **Steel Deck (w/ Overlay)**

Rating Exercise

Use the photos, field conditions, and dimensions given on pages 5.3.15 – 5.3.16. Rate the subject concrete deck.

NBI Component Rating Method:

Circle the rating for this deck and explain why this rating was chosen (rating reasoning).

Deck Condition Rating = 9 8 7 6 5 **4** 3 2 1 0

Deck is in “poor” condition structurally. The steel pans have areas of 100% section loss with 3 mm (1/8”) section loss to primary bearing bars between beams 6 & 7 and 1 & 2 for full length of deck and beams 2-4 for 2 m (6’) from FAB. The typical condition of the deck is random areas of heavy rusting including bearing bars.

Area provided for notes or calculations:

| Element | Total Quantity | Unit | Quantities in Condition States | | | | |
|-----------------------------|---------------------------------|------|--------------------------------|---|---|---|---|
| | 1 | | 2 | 3 | 4 | 5 | |
| 29 Steel Concrete Filled | Core Elements | | | | | | |
| | 1 63 m ² (720 SF) | EA | | | | | 1 |
| | | | | | | | |
| | Other Elements | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | Smart Flags | | | | | | |
| | | | | | | | |
| | | | | | | | |

Topic 5.4 – Deck Joints, Drainage Systems, Lighting and Signs

Element Level Method

- Determine CoRe Elements and their numbers
- Calculate quantities
- Determine correct condition states

Use the current (or Agency CoRe Element Guide if supplied) AASHTO CoRe Element Guide.



Photo 1: Central view of deck surface. There are three pourable joint seals which are each 12 m (40') long.



Photo 2: Brown staining on side of pier (not rust stains). This condition also exists on far (east) abutment.

Area provided for notes or calculations:

| Element | Total Quantity | Unit | Quantities in Condition States | | | | |
|----------------------------|-------------------|-----------|--------------------------------|------------|---|---|---|
| | | | 1 | 2 | 3 | 4 | 5 |
| 301 Pourable Joint Seal | CoRe Elements | | | | | | |
| | 36 (120) | m (LF) | 12 (40) | 24 (80) | | | |
| | | | | | | | |

Topic 6.1 – Solid Sawn Timber Bridges

Deck documentation exercise (notes and sketch)

Total Quantity:

**Total beam quantity = 7 beams x 8 m L = 56 m or
7 beams x 26' L = 182 LF**

Inspection notes:

2 m (6') long horizontal shear crack @ end of fascia beam (see Sketch). Both fascia beams with moderate sized surface checks. Interior beams w/ scattered mold & stain w/ little decay & no section loss.

Check List

✓ Member
Description

✓ Defect Locations

✓ Defect
Description
/Severity

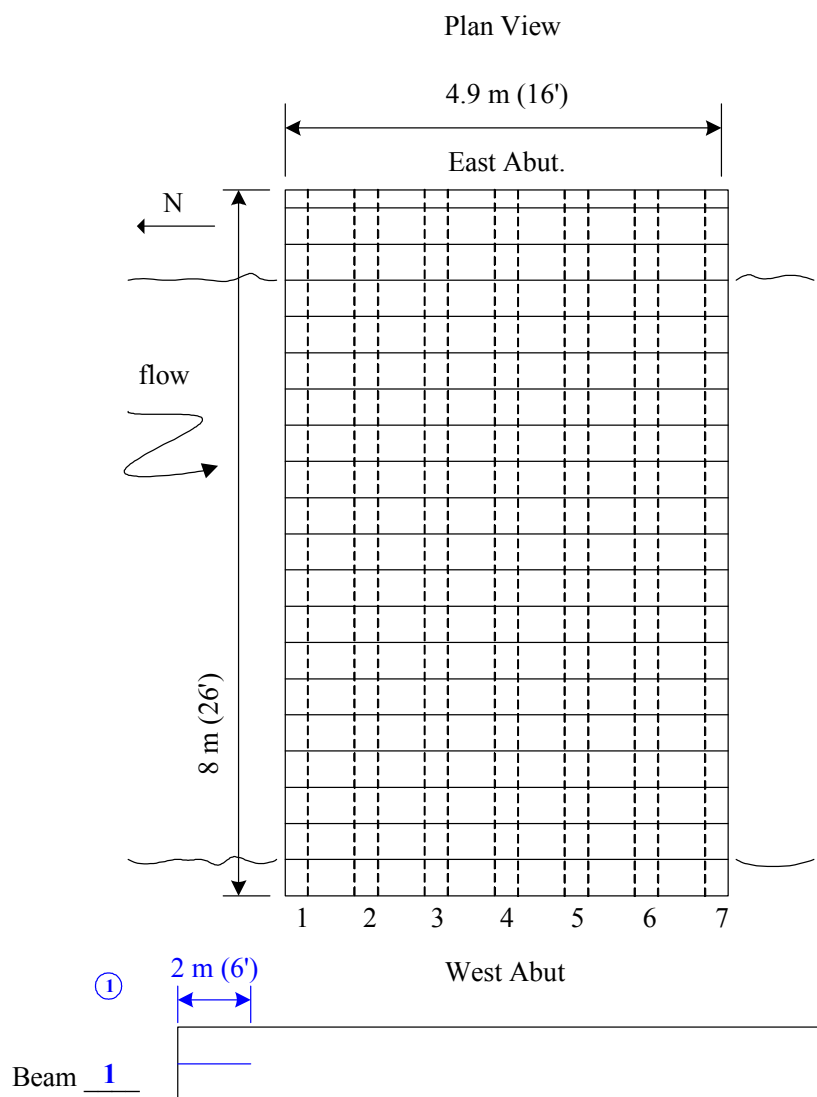
✓ Defect
Dimensions

✓ Defect Quantity
(if required)

① Horizontal shear crack in fascia beam (see Photo 2).

② Moderate surface check on both fascia beams (see Photo 3).

③ Mold & stain (see Photo 4)



Member Timber Beam (Girder)

Rating Exercise

Use the photos, field conditions, and dimensions given on pages 6.1.18 – 6.1.19. Rate the subject solid sawn timber multi-beam superstructure.

NBI Component Rating Method:

Circle the rating for this superstructure and explain why this rating was chosen (rating reasoning).

Superstructure Condition Rating = 9 8 7 **6** 5 4 3 2 1 0

Superstructure is in “satisfactory” condition structurally. The beams that are the primary structural members are generally sound. They do not have any section loss, but they do have molds and stains, which may indicate the beginning of decay fungi. Surface checks on fascia beams are minor defects, but do indicate extensive weathering. The horizontal shear crack on the fascia beam is localized and is not seriously affecting the capacity of the structure at this time.

Area provided for notes or calculations:

Horizontal shear crack 2 m (6 LF) Beam 1 CS 3
 Fascia beams moderate size surface checks CS 2
 $[8 \text{ m} + 8 \text{ m}] - 2 \text{ m for CS 3} = 14 \text{ m}$
 $(26' + 26') - 6' \text{ for CS 3} = 46 \text{ LF}$

Total – CS 3 – CS 2 = CS 1
 $56 \text{ m} - 14 \text{ m} - 2 \text{ m} = 40 \text{ m}$
 $182' - 46' - 6' = 130 \text{ LF}$

| Element | Total Quantity | Unit | Quantities in Condition States | | | | |
|------------------------|----------------|-----------|--------------------------------|------------|----------|---|---|
| | | | 1 | 2 | 3 | 4 | 5 |
| 111 Timber Open Girder | CoRe Elements | | | | | | |
| | 56 (182) | m (LF) | 40 (130) | 14 (46) | 2 (6) | | |
| | | | | | | | |

| | | | | | | | |
|-----------------------|--|--|--|--|--|--|--|
| <i>Other Elements</i> | | | | | | | |
| | | | | | | | |

| | | | | | | | |
|--------------------|--|--|--|--|--|--|--|
| <i>Smart Flags</i> | | | | | | | |
| | | | | | | | |

Topic 6.2 – Glulam Timber Bridges

Deck documentation exercise (notes and sketch)

Total Quantity:

**Total beam quantity = 7 beams x 21.3 m L = 149 m or
7 beams x 70' L = 490 LF**

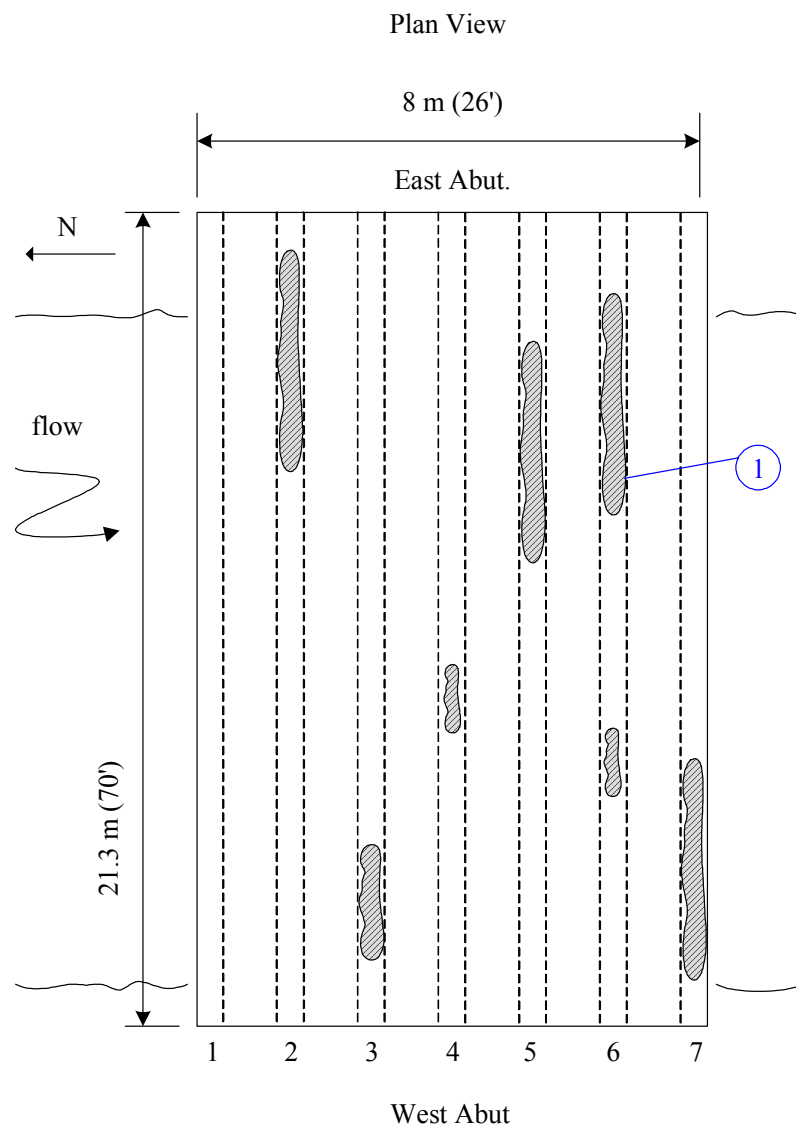
Inspection notes:

Max. shear zones @ beam ends near supports, no deficiencies found. Max. flexure zones near mid-span, no deficiencies except scattered water stains typical. Stained areas show no signs of decay. Diaphragms free of defects.

Check List

- ✓ Member Description
- ✓ Defect Locations
- ✓ Defect Description /Severity
- ✓ Defect Dimensions
- ✓ Defect Quantity (if required)

① Scattered water staining on beams (see photos 3 & 4).



Member **Timber Open Girder**

Rating Exercise

Use the photos, field conditions, and dimensions given on pages 6.2.15 – 6.2.16. Rate the subject glulam timber multi-beam superstructure.

NBI Component Rating Method:

Circle the rating for this superstructure and explain why this rating was chosen (rating reasoning).

Superstructure Condition Rating = 9 **8** 7 6 5 4 3 2 1 0

Superstructure is in “very good” condition structurally. The beams which are the primary structural members, are sound with no noteworthy deficiencies or decay found. Close-up inspection of the scattered water staining on the beams indicated that no decay has begun on the beams.

Area provided for notes or calculations:

| Element | Total Quantity | Unit | Quantities in Condition States | | | | |
|------------------------|----------------|-----------|--------------------------------|---|---|---|---|
| | | | 1 | 2 | 3 | 4 | 5 |
| 111 Timber Open Girder | CoRe Elements | | | | | | |
| | 149 (490) | m (LF) | 149 (490) | | | | |
| | | | | | | | |

| | | | | | | | |
|-----------------------|--|--|--|--|--|--|--|
| <i>Other Elements</i> | | | | | | | |
| | | | | | | | |

| | | | | | | | |
|--------------------|--|--|--|--|--|--|--|
| <i>Smart Flags</i> | | | | | | | |
| | | | | | | | |

Topic 7.1 – Cast in Place Slabs

Substructure documentation exercise (notes and sketch)

Total Quantity:

Slab: 9 m length x 8 m width c/c = 72m²
(29' length x 26' width c/c = 754 ft²)

Inspection notes:

No spalls or delaminations noted on top surface of the deck.

Corner spalls on both underside edges.

Random map cracking and dark spots on underside of slab throughout.

Check List

✓ Member
Description

✓ Defect Locations

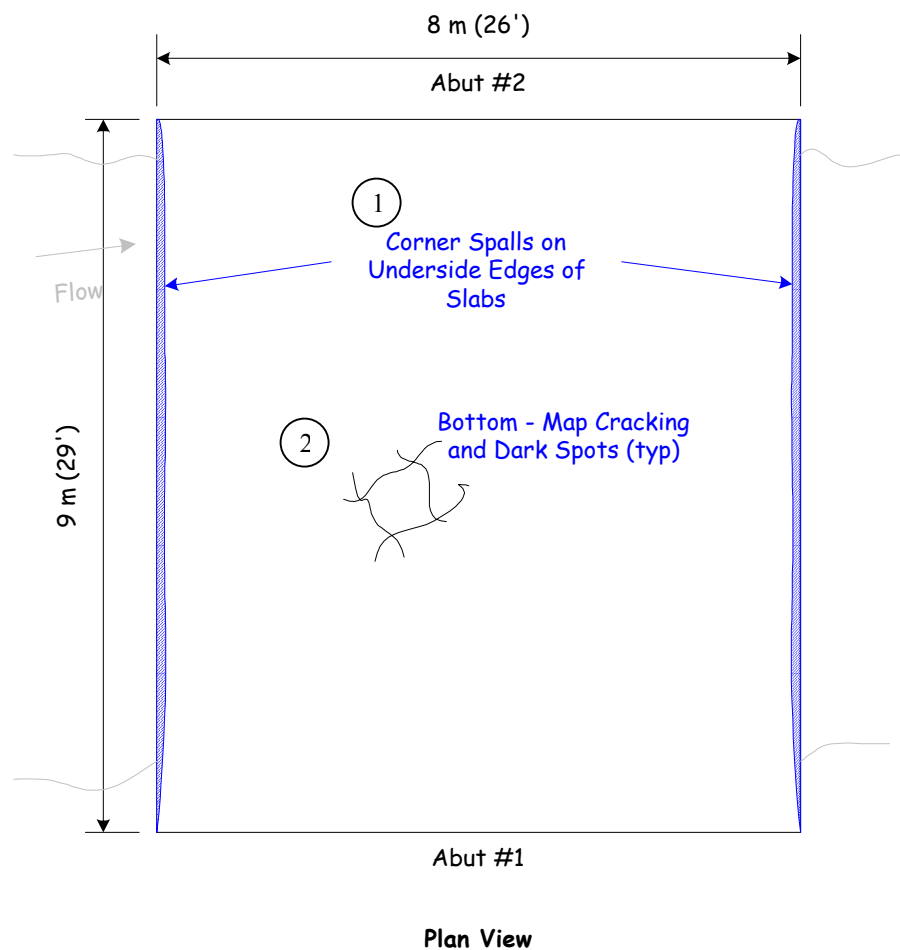
✓ Defect
Description
/Severity

✓ Defect
Dimensions

✓ Defect Quantity
(if required)

① Corner Spalls
(see photo 1)

② Map Cracking and
Dark Spots
(see photo 2)



Member Cast-in-Place Slab - Bare

Rating Exercise

Use the photos, field conditions, and dimensions given on pages 7.1.10 – 7.1.11. Rate the single span CIP concrete slab bridge.

NBI Component Rating Method:

Circle the rating for this superstructure and explain why this rating was chosen (rating reasoning).

Superstructure Condition Rating = 9 8 7 6 5 4 3 2 1 0

The superstructure is in satisfactory structural condition. The slab shows some minor deterioration. No structural cracks were found.

Area provided for notes or calculations:

| Element | Total Quantity | Unit | Quantities in Condition States | | | | |
|-------------------------|------------------------------------|------|--------------------------------|---|---|---|---|
| | | | 1 | 2 | 3 | 4 | 5 |
| 38 Concrete Slab – Bare | CoRe Elements | | | | | | |
| | 1 72 m ² (754 SF) | EA | 1 | | | | |
| | | | | | | | |

| | | | | | | | |
|-----------------------|--|--|--|--|--|--|--|
| <i>Other Elements</i> | | | | | | | |
| | | | | | | | |

| | | | | | | | |
|--|---|----|---|---|--|--|--|
| <i>Smart Flags</i> | | | | | | | |
| 358 Deck Cracking | 1 | EA | 1 | | | | |
| 359 Soffit of Concrete Decks and Slabs | 1 | EA | | 1 | | | |

Topic 7.2 – Tee Beams

Deck documentation exercise (notes and sketch)

Total Quantity:

**Total beam quantity = 4 beams x 25' L = 100 LF or
4 beams x 7.6 m L = 30.4 m say 30.5 m**

**Deck = 25' c/c Span x 18' wide = 450 SF or
7.6 m c/c span x 5.5 m wide = 42 m²**

Inspection notes:

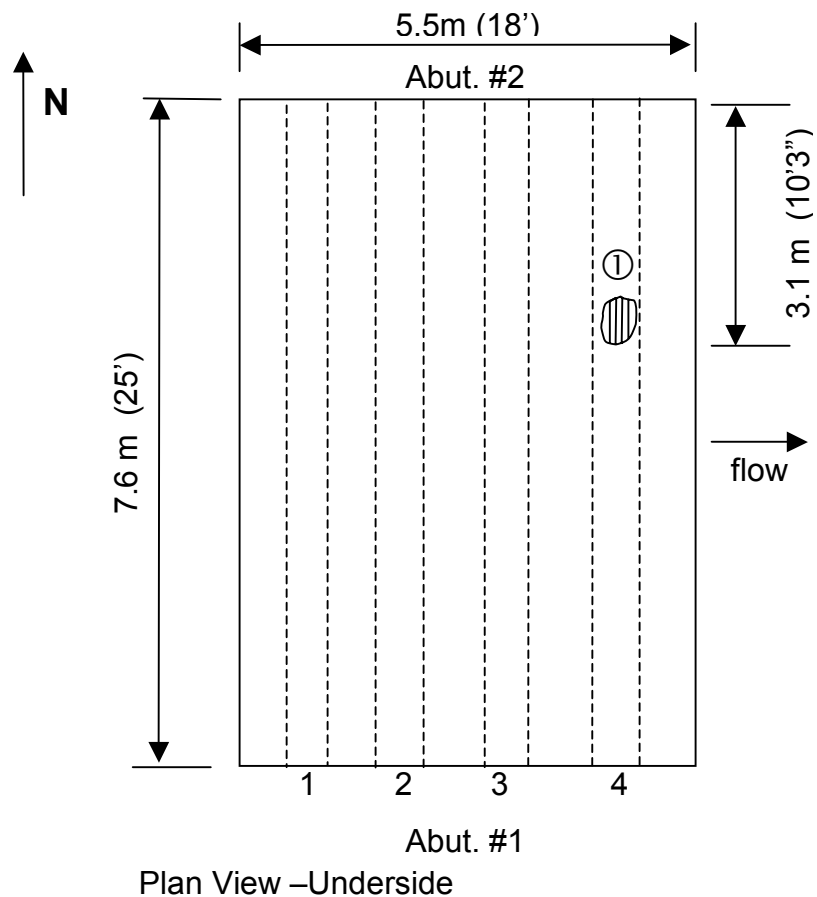
Concrete tee beams with 3 of 4 beams showing no signs of deterioration. Beam #4 has 305 mm (12") dia. X 102 mm (4") deep spall area located 3.125 m (10'3") from abut. #2. The 4 exposed #8 bars are spaced at 102 mm (4") and the measured diameters are ≈ 17 mm (11/16") remaining section.

Underside of deck in good condition (photo 2)

Check List

- ☒ Member Description
- ☒ Defect Locations
- ☒ Defect Description /Severity
- ☒ Defect Dimensions
- ☒ Defect Quantity (if required)

① 305 mm (12") diameter x 102 mm (4") deep spall. Four exp. #8 rebar w/ 17 mm (11/16") remaining section (see Photo 3).



Member type Concrete Open Beam/Girder

Rating Exercise

Use the photos, field conditions, and dimensions given on pages 7.2.10 – 7.2.11. Rate the subject reinforced concrete tee beam superstructure.

NBI Component Rating Method:

Circle the rating for this superstructure and explain why this rating was chosen (rating reasoning).

Deck Condition Rating = 9 8 **7** 6 5 4 3 2 1 0

Superstructure Condition Rating = 9 8 7 6 5 **4** 3 2 1 0

Superstructure is in “poor” condition structurally. Tee beam #4, which is a primary structural member, has advanced section loss of the main tension reinforcement near mid-span. Therefore all primary structural elements are not sound. Although the guidelines call for an overall characterization of the general condition of the entire component being rated, the rating of “5” states that all primary Structural elements are sound but may have minor section loss, cracking, or spalling. In this case, “4” is the most appropriate rating because not all primary members are sound.

Underside of the deck is in good condition (photo 2). Top side of deck is not visible due To asphalt wearing surface.

Area provided for notes or calculations:

| Element | Total Quantity | Unit | Quantities in Condition States | | | | |
|--|--------------------------|--------|--------------------------------|---|---|------------|---|
| | | | 1 | 2 | 3 | 4 | 5 |
| CoRe Elements | | | | | | | |
| 110 RC Open Girder | 30.5 (100) | m (LF) | 30 (99) | | | 0.5 (1) | |
| 13 Concrete Deck (unprotected with AC Overlay) | 1 (42 m²) (450 SF) | EA | 1 | | | | |
| Smart Flags | | | | | | | |
| 359 Soffit of Concrete Decks and Slabs | 1 | EA | 1 | | | | |

Topic 7.3 – Concrete Two-Girder Systems

Deck documentation exercise (notes and sketch)

Total Quantity:

Girders: 11 m span x 2 = 22 m (36' span x 2 = 72 LF)

Deck: 11 m span x 7 m c/c = 77 m² (36' span x 22' c/c = 792 SF)

Inspection notes:

Hairline to 3 mm (1/8") vertical cracks on inside of girder faces. 460 mm x 250 mm (18" x 10") spall with exposed rebar at midspan of upstream girder. 760 mm x 480 mm (30" x 19") spall at 4/5 span with exposed rebar and 2 mm (1/16") section loss of downstream girder. 610 mm x 150 mm (24" x 6") spall at midspan with exposed rebar and 2 mm (1/16") section loss of downstream girder. Underside of deck has extensive transverse cracking with heavy efflorescence.

Check List

√ Member
Description

√ Defect Locations

√ Defect
Description
/Severity

√ Defect
Dimensions

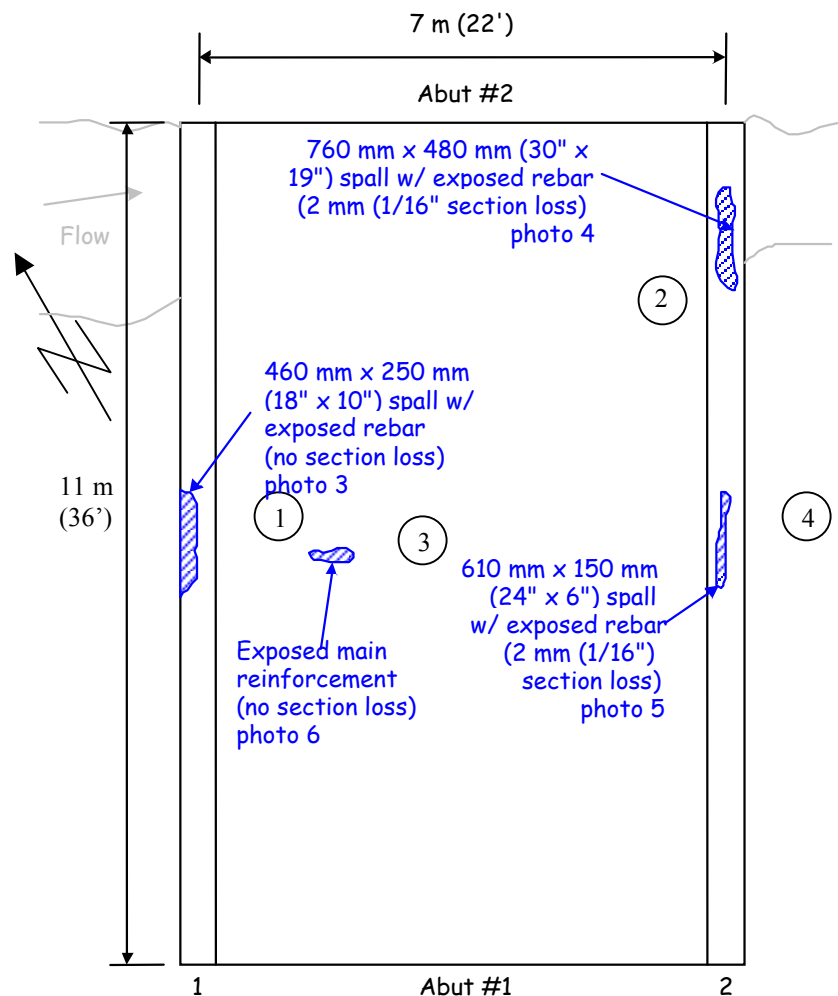
√ Defect Quantity
(if required)

① See Photo 3

② See Photo 4

③ See Photo 6

④ See Photo 5



Plan View

Member Concrete Through Girders

Rating Exercise

Use the photos, field conditions, and dimensions given on pages 7.3.11 – 7.3.13. Rate the subject concrete through girder bridge.

NBI Component Rating Method:

Circle the rating for the superstructure and explain why this rating was chosen (rating reasoning).

Superstructure Condition Rating = 9 8 7 6 5 4 3 2 1 0

It is in fair condition structurally. The primary structural elements (girders) are basically sound, showing three spalls with some minor section loss, and some random vertical cracks.

Area provided for notes and calculations:

| | | |
|---|------|-----------------|
| ➤ 18" x 10" spall, exposed rebar | 1.5' | (Photo 3) CS. 3 |
| ➤ 30" x 19" spall, exposed rebar | 2.5' | (Photo 4) CS. 3 |
| ➤ 24" x 6" spall, exposed rebar w/ 1/16" section loss | 2.0' | (Photo 5) CS. 3 |
| | 6.0' | |

| Element | Total Quantity | Unit | Quantities in Condition States | | | | |
|--------------------|----------------|--------|--------------------------------|---|----------|---|---|
| | | | 1 | 2 | 3 | 4 | 5 |
| 110 RC Open Girder | CoRe Elements | | | | | | |
| | 22 (72) | m (LF) | 20 (66) | | 2 (6) | | |
| | | | | | | | |

| | | | | | | | |
|--------------------|--|--|--|--|--|--|--|
| <i>Smart Flags</i> | | | | | | | |
| | | | | | | | |

Topic 7.4 – Concrete Channel Beams

Superstructure documentation exercise (notes and sketch)

Total Quantity

***Beams: 11 lines x 33 m (108') span = 363 m (1188 LF)**

Deck: 33 m (108') span x 12 m (39') c/c = 396 m² (4212 SF)

Inspection notes:

No problems with bearing areas and shear zones.

Hairline vertical flexure cracks found on 12 of the beams.

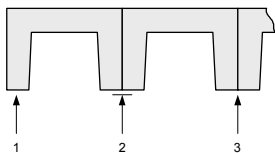
No noteworthy problems with any of the flange tie bolts and diaphragms were in good condition. Asphalt overlay exhibited full-length longitudinal hairline cracks near wheel paths.

Check List

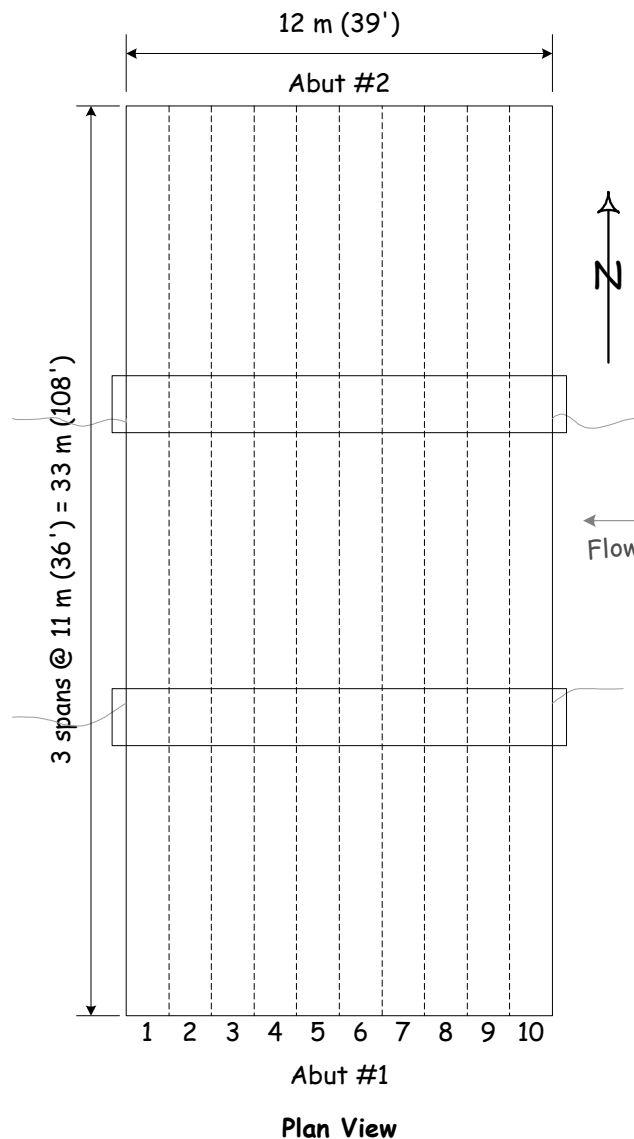
- ☒ Member Description
- ☒ Defect Locations
- ☒ Defect Description /Severity
- ☒ Defect Dimensions
- ☒ Defect Quantity (if required)

Note: Hairline flexure cracks found on 12 of the beams.

***Instructor Note**
Beam lines (2 Faces)



Number of Exterior webs divided by 2
(22 faces / 2 = 11 beams) AASHTO



Member Precast Channel Beam (Mild Reinforcement)

Rating Exercise

Use the photos, field conditions, and dimensions given on pages 7.4.10 – 7.4.12. Rate the subject concrete channel beam bridge.

NBI Component Rating Method:

Indicate the item number, circle the rating for the channel beam superstructure, and provide reasoning for the rating.

Deck Condition Rating = 9 8 7 6 5 4 3 2 1 0

Superstructure Condition Rating = 9 8 7 6 5 4 3 2 1 0

It is in good condition structurally. The primary elements (channel beams) are sound with only hairline flexure cracks noted.

Area provided for notes and calculations:

- 12 Beams with hairline cracks (**Condition State 2**)

$$12 \times 11 \text{ m} = 132 \text{ m}$$

$$12 \times 36' = 432'$$

CS 1

$$1188 - 432' = 756 \text{ LF}$$

$$363 - 132 \text{ m} = 231 \text{ m}$$

| Element | Total Quantity | Unit | Quantities in Condition States | | | | |
|--|---|--------|--------------------------------|--------------|---|---|---|
| | | | 1 | 2 | 3 | 4 | 5 |
| CoRe Elements | | | | | | | |
| 110 RC Open Girder | 329 (1188) | m (LF) | 198 (756) | 132 (432) | | | |
| 13 Concrete Deck Unprotected with AC Overlay | 1 (391 m ²) (4212 SF) | EA | 1 | | | | |

| | | | | | | | |
|---|---|----|---|--|--|--|--|
| <i>Smart Flags</i> | | | | | | | |
| 359 Soffit of Concrete Decks and Slabs | 1 | EA | 1 | | | | |

Topic 7.5 – Concrete Arches and Arch Culverts

Superstructure documentation

Total Quantity:

Arch culvert: Use the barrel length of 7 m (22 LF)

Inspection notes:

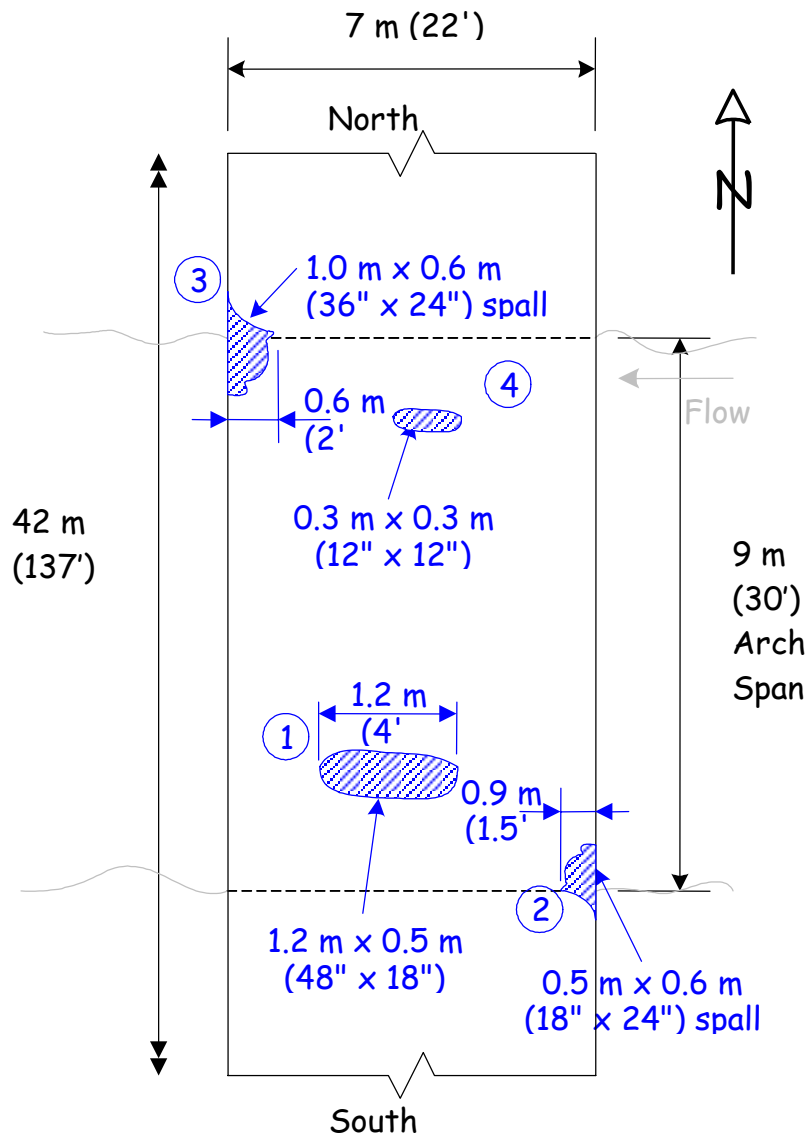
Cracking, efflorescence, scaling, and spalling in an area 1.2 m x 0.46 m (48" x 18") on the south underside face of the arch (Photo 2). A large corner spall 0.46 m x 0.3 m (18" x 12") at the southeast corner of the arch (Photo 4). Cracking, efflorescence, scaling, and spalling in an area 0.3 m x 0.3 m (12" x 12") of the north underside face of the arch (Photo 5). A large corner spall 0.9 m x 0.6 m (36" x 24") at the northeast corner of the arch (Photo 8).

Check List

- ✓ Member Description
- ✓ Defect Locations
- ✓ Defect Description /Severity
- ✓ Defect Dimensions
- ✓ Defect Quantity (if required)

① Cracking, spalling (see Photo 2)

② Large corner spall (see Photo 4)



Member Reinforced Concrete Arch Culvert

Rating Exercise

Use the photos, field conditions, and dimensions given on pages 7.5.17 – 7.5.19. Rate the subject closed spandrel concrete arch culvert.

NBI Component Rating Method:

Circle the rating for the superstructure and explain why this rating was chosen (rating reasoning).

Superstructure Condition Rating = 9 8 7 6 5 4 3 2 1 0

It is in fair structural condition. The concrete arch is generally sound but has some cracking, scaling and spalling. The structural capacity of the structure appears unaffected by the deterioration.

Area provided for notes and calculations:

Spalls

① 4' – CS – 3

② 1.5' – CS – 3

③ 2' – CS – 3

④ -* - CS – 3
7.5' (say 8') or 2.4 m say 3 m

* 1 cancels it out. If ④ condition state would have been worse, it would have governed.

| Element | Total Quantity | Unit | Quantities in Condition States | | | | |
|--------------------------------------|----------------|-----------|--------------------------------|---|----------|---|---|
| | | | 1 | 2 | 3 | 4 | 5 |
| 241 Reinforced Concrete Arch Culvert | CoRe Elements | | | | | | |
| | 7 (22) | m (LF) | 4 (14) | | 3 (8) | | |
| | | | | | | | |

| | | | | | | | |
|--------------------|--|--|--|--|--|--|--|
| <i>Smart Flags</i> | | | | | | | |
| | | | | | | | |

Topic 7.6 – Concrete Rigid Frames

Superstructure documentation exercise (notes and sketch)

Total Quantity:

Slab: 21 m x 24 m c/c = 504 m²
(slab-supported by substructure)
68' x 78' c/c = 5304 SF

Abutment: 24 m + 1 m x 2 abutments = 50 m
78' + 3' x 2 abutments = 162 LF

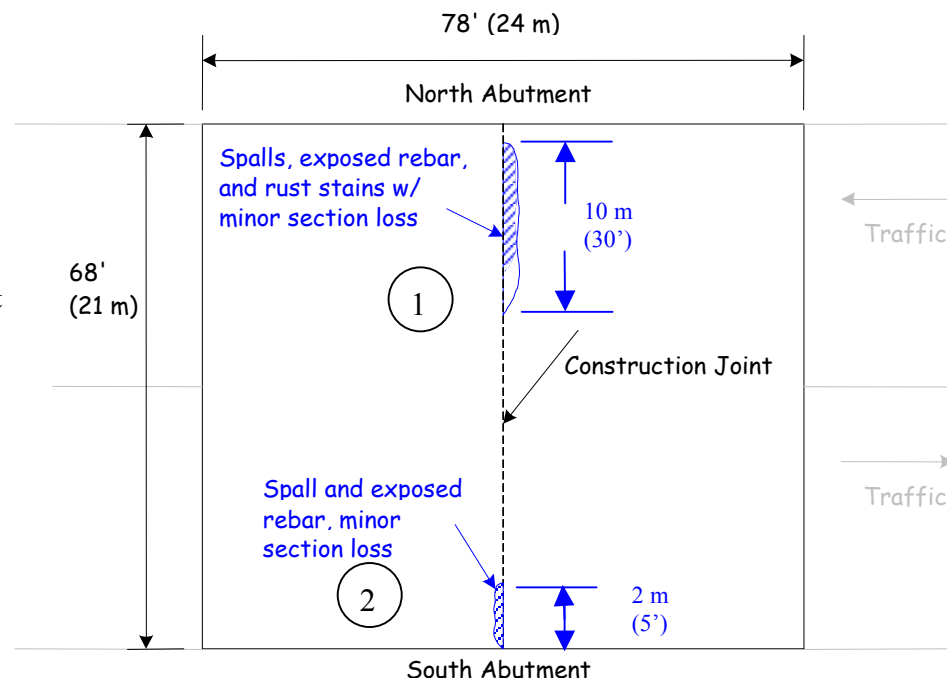
Inspection notes:

Fascia areas of slab were generally in satisfactory condition. Vertical corners were generally in good condition. No cracks were found in faces of legs. Underside of slab at north end has several spalls, exposed rebar, and rust stains at construction joint. Only minor section loss. The construction joint at frame legs has areas of spalling and exposed rebar with minor section loss. The asphalt-wearing surface is in good condition.
No problems noted in the vertical walls.

Check List

- ✓ Member Description
- ✓ Defect Locations
- ✓ Defect Description /Severity
- ✓ Defect Dimensions
- ✓ Defect Quantity (if required)

- ① Spalls, exposed rebar and rust stains at joint (see photo 3)
- ② Spall and exposed rebar with minor section loss (see photo 5)



Member Concrete Slab with Overlay Concrete Abutment

Rating Exercise

Use the photos, field conditions, and dimensions given on pages 7.6.11 – 7.6.13. Rate the subject concrete rigid frame bridge.

NBI Component Rating Method:

Circle the rating for the superstructure and explain why this rating was chosen (rating reasoning).

Superstructure Condition Rating = 9 8 7 6 5 4 3 2 1 0

Substructure Condition Rating = 9 8 7 6 5 4 3 2 1 0

It is in satisfactory structural condition. The frame slab (superstructure) has a minor amount of rebar section loss and spalling along the construction joint.

Area for notes and calculations:

359 – (10' x 5') 1' wide / (68' x 78')=0.3%

215 – No problems noted (photo 2)

39 – AC Overlay – No problems noted

Affected area $\frac{(30' \times 2' \text{ max} + 5' \times 2')}{5304} = 1.3\%$

| Element | Total Quantity | Unit | Quantities in Condition States | | | | |
|--|--------------------------|-----------|--------------------------------|---|---|---|---|
| | | | 1 | 2 | 3 | 4 | 5 |
| CoRe Elements | | | | | | | |
| 39 Concrete Slab – Unprotected w/ AC Overlay 215 Abutment | 1 504 m² (5304 SF) | EA | 1 | | | | |
| | 50 (162) | m (LF) | 50 (162) | | | | |

| | | | | | | | |
|-----------------------|--|--|--|--|--|--|--|
| <i>Other Elements</i> | | | | | | | |
| | | | | | | | |

| | | | | | | | |
|---|---|----|---|--|--|--|--|
| <i>Smart Flags</i> | | | | | | | |
| 359 Soffit of Concrete Decks and Slabs | 1 | EA | 1 | | | | |

Topic 7.7 – Precast and Prestressed Slabs**Superstructure documentation exercise (notes and sketch)**

Total Quantity

Slab Beams: *1 beam x 10 m = 10 m**1 beam x 32.5' = 32.5'****6 x 10 m = 60 m****(6 x 32.5' = 195 LF)****Slab: 10 m x 1.2 m/beam x 6 beams = 72 m²****32.5' x 4'/beam x 6 beams = 780 SF**

Inspection notes:

Underside of slab units showed minor scaling and spalling of the concrete along the joints with signs of leakage. Lateral posttension ties showed no defects. Asphalt wearing surface did not have any reflective cracks.

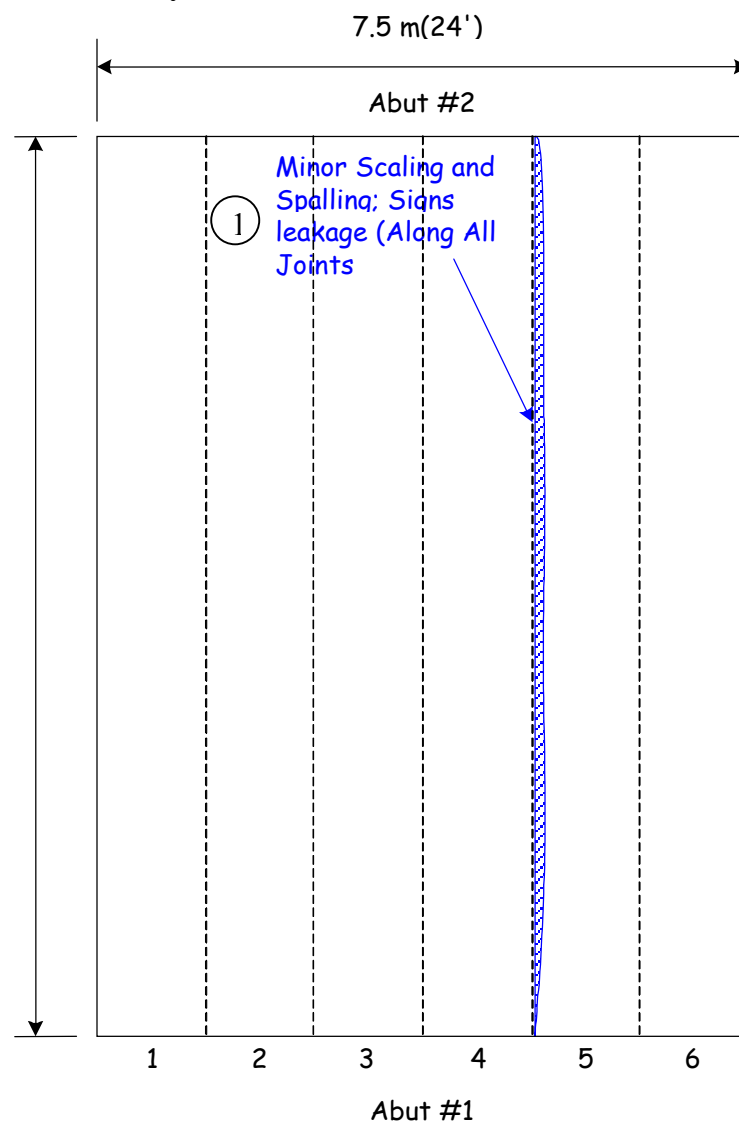
Check List

- ✓ Member Description
- ✓ Defect Locations
- ✓ Defect Description /Severity
- ✓ Defect Dimensions
- ✓ Defect Quantity (if required)

- ① Signs of leakage at all joints (see photos 5 – 7)

*AASHTO Method of counting beams (similar to channel beams Topic 7.4)
Number of exterior webs / 2

10 m
(32.5')



Plan View

Member Closed Web/Box Girder

Rating Exercise

Use the photos, field conditions, and dimensions given on pages 7.7.10 – 7.7.12. Rate the subject prestressed concrete slab bridge.

NBI Component Rating Method:

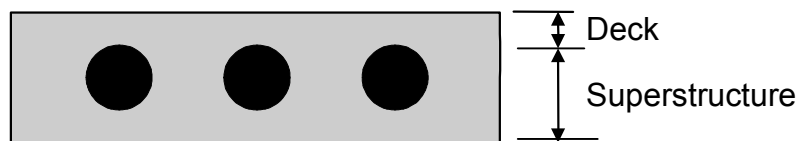
Circle the rating for the superstructure and deck and explain why these ratings were chosen (rating reasoning).

Superstructure Condition Rating = 9 8 7 6 5 4 3 2 1 0

Deck Condition Rating = 9 8 7 6 5 4 3 2 1 0

It is in good structural condition. The primary structural elements (slab units) show only minor deterioration and damage. Two rust stains, a little joint leakage, occasional edge deterioration at some joints are too minor to warrant a “6”

Area provided for notes or calculations:



Instructor Note: No smart flags for deck/slab since neither top or bottom surfaces visible.

| Element | Total Quantity | Unit | Quantities in Condition States | | | | |
|---|------------------------------------|----------------------------|--------------------------------|---------------------|---|---|---|
| | | | 1 | 2 | 3 | 4 | 5 |
| CoRe Elements | | | | | | | |
| 104 Closed Web/Box Girder | 10 (33) 60 (195) | m (LF) m (LF) | | 10 (33) 60 (195) | | | |
| *39 Concrete Slab – Unprotected w/ AC Overlay | 1 72 m ² (780 SF) | EA m ² SF | 1 | | | | |
| Other Elements | | | | | | | |
| | | | | | | | |
| Smart Flags | | | | | | | |
| * * | | | | | | | |

* Top of slab beam serves as a deck – we have to have a deck (No reflective cracking on asphalt W.S.)

* * No soffit since under side of superstructure (not) deck or slab visible

Topic 7.9 – Prestressed I-Beams

Superstructure documentation

Total Quantity for Element Level Inspection

Beams: 12 m x 10 beams x 2 spans = 240

+ 21 m x 14 beams x 2 spans = 588 = 828 m

(40' x 10 beams x 2 spans = 800

+ 69' x 14 beams x 2 spans = 1932 = 2732 LF)

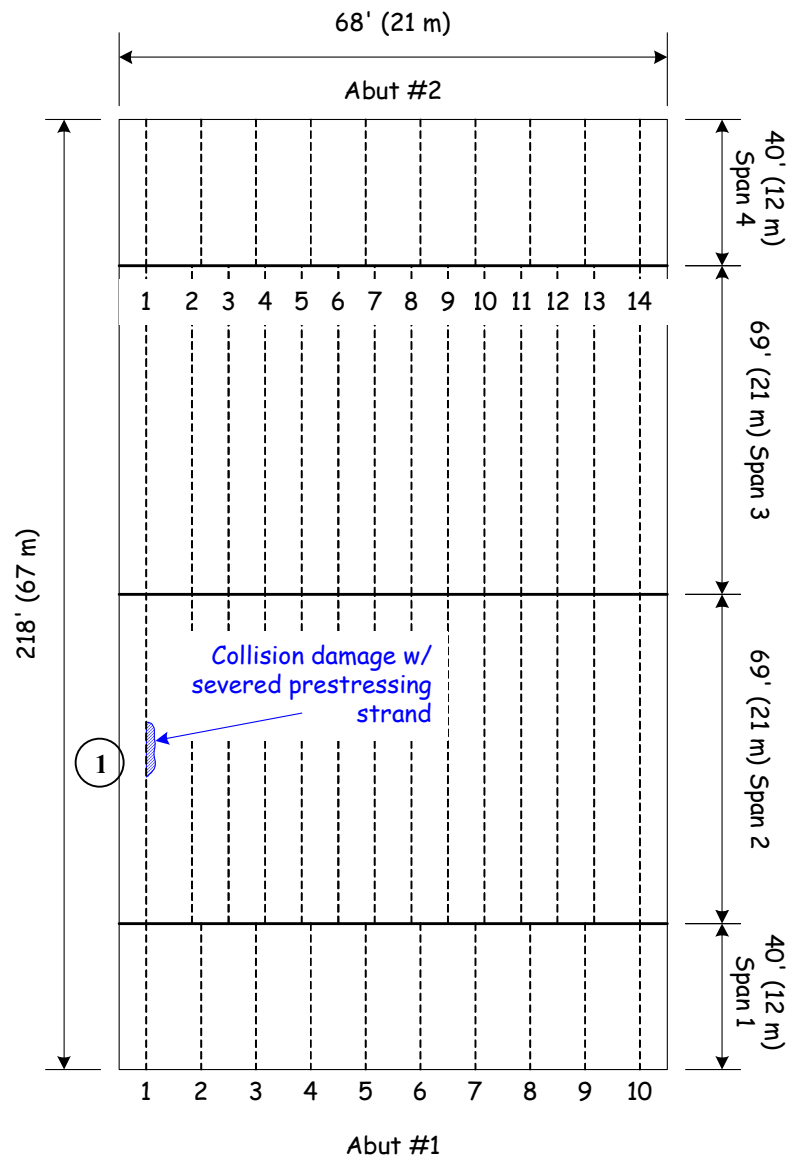
Inspection notes:

Collision damage to bottom flange of Beam #1 – Span 2 with severed prestressing strand. There is evidence of additional collision damage to same spot. No cracks discovered.

Check List

- ✓ Member Description
- ✓ Defect Locations
- ✓ Defect Description /Severity
- ✓ Defect Dimensions
- ✓ Defect Quantity (if required)

- ① Collision damage with severed prestressing strand (see photos 3, 4 and 5)



Plan View

Member Prestressed Concrete Open Girder/Beam

Rating Exercise

Use the photos, field conditions, and dimensions given on pages 7.9.12 – 7.9.14. Rate the subject prestressed I-beam bridge.

NBI Component Rating Method:

Circle the rating for the superstructure and explain why this rating was chosen (rating reasoning).

Superstructure Condition Rating = 9 8 7 6 5 4 3 2 1 0

It is in fair structural condition. The rating reason includes the following:

- The severed strand is example of local failure.
- Noncritical collision damage to structural element.
- Only one strand broken.
- No camber loss noted.
- No evidence of structural distress.
- Large number of beams.
- No other cracks noted.

Area provided for notes and calculations:

| Element | Total Quantity | Unit | Quantities in Condition States | | | | |
|--------------------------------------|----------------|--------|--------------------------------|---|---|---------|---|
| | | | 1 | 2 | 3 | 4 | 5 |
| CoRe Elements | | | | | | | |
| 109 Prestressed Concrete Open Girder | 833 (2732) | m (LF) | 832.5 (2731) | | | 0.5 (1) | |
| | | | | | | | |

| | | | | | | | |
|-----------------------|---|----|--|--|---|--|--|
| <i>Other Elements</i> | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| <i>Smart Flags</i> | | | | | | | |
| 362 Traffic Impact | 1 | EA | | | 1 | | |

Topic 7.10 – Prestressed Box-Beams

Superstructure documentation

Total Quantity

Beams: 12 m x 1 Bm = 12 m

38' x 1 Bm = 38'

12 m span x 7 = 84 m

38' span x 7 = 266 LF

Deck: 8.5 m x 12 m = 102 m²

28' x 38' = 1064 SF

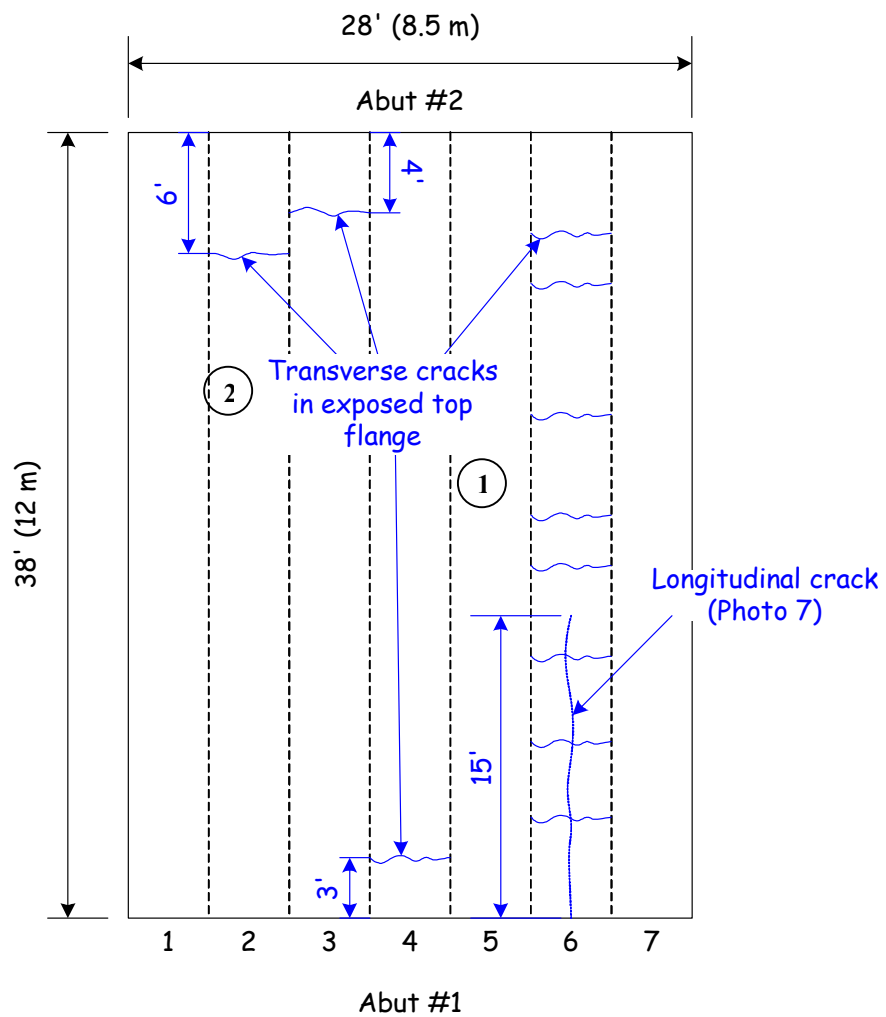
Inspection notes:

Transverse cracks found in exposed top flange of Beam #6 for its full length, Beam #3 for 1 m (4') from Abut 2, Beam #2 for 2 m (6') from Abut 2, and Beam #4 for 1 m (3') from Abut 1. Joints b/n box beams typically leak, but no sign of rust stains or damage of the reinforcement. Transverse flexure cracks also found in the center 2 m (6') of the bottom flange of four box beams. Longitudinal crack and spall on the underside of Beam #6 extending from Abut 1 for 5 m (15') towards midspan.

Check List

- ✓ Member Description
- ✓ Defect Locations
- ✓ Defect Description /Severity
- ✓ Defect Dimensions
- ✓ Defect Quantity (if required)

- ① Transverse cracks were found throughout beam #6. (see photos 2 & 3)
- ② Transverse flexure cracks found in center 6' of the bottom flange of four box beams. (see photos 4 – 6)



Plan View

Member Prestressed Concrete Closed Web/Box Girder

Rating Exercise

Use the photos, field conditions, and dimensions given on pages 7.10.13 – 7.10.15. Rate the subject prestressed box beam bridge.

NBI Component Rating Method:

Circle the rating for the superstructure and deck and explain why these ratings were chosen (rating reasoning).

Superstructure Condition Rating = 9 8 7 6 5 4 3 2 1 0

Deck Condition Rating = 9 8 7 6 5 4 3 2 1 0

It is in poor structural condition. The primary structural members, the box beams, have structural cracks and advanced deterioration and spalling. The top flange transverse cracks are not due to flexure. They are a result of insufficient dead load and likely have been present since the beams were erected. Likewise, the longitudinal crack on the bottom of one beam is again not likely due to flexure, but more probably due to premature release of one or two strands at that corner. The longitudinal crack, however, is worsening. The transverse cracks in the bottom flange of the four beams are flexure cracks and it's relevant that they are "working" cracks, with loss of camber and differential deflection noted.

Area provided for notes or calculations:

| Multiple Girders | Single Girder |
|---|--|
| CS4 Photos 4 – 6: 4 (2 m) = 8 m (4 beams) 4 (6') = 24' | CS4 2 m (6') |
| CS3 Photo 7: 5 m or 15' | CS3 5 m (15') |
| CS2 84 m – 5 m – 8 m = 71 m 266' – 15' – 24' = 227' | CS2 12 m – 5 m – 2 m = 5 m 38' – 6' – 15' = 17' |

| Element | Total Quantity | Unit | Quantities in Condition States | | | | |
|--|---------------------|------------------|--------------------------------|--------------------|------------------|-----------------|---|
| | | | 1 | 2 | 3 | 4 | 5 |
| CoRe Elements | | | | | | | |
| 104 Prestressed Concrete Closed Web/Box Girder | 12 (38) 84 (266) | m (LF) m (LF) | | 5 (17) 71 (227) | 5 (15) 5 (15) | 2 (6) 8 (24) | |
| 12 Concrete Bare Unprotected | 1 | EA | 1 | | | | |

| | | | | | | | |
|-----------------------|--|--|--|--|--|--|--|
| <i>Other Elements</i> | | | | | | | |
| | | | | | | | |

| | | | | | | | |
|--------------------|---|----|--|--|---|--|--|
| <i>Smart Flags</i> | | | | | | | |
| 358 Deck Cracking | 1 | EA | | | 1 | | |

Topic 7.11 – Concrete Box Culverts**Rating Exercise**

Use the photos, field conditions, and dimensions given on pages 7.11.24 – 7.11.26. Rate the subject segmental concrete box girder bridge.

NBI Component Rating Method:

Circle the rating for the superstructure and explain why this rating was chosen (rating reasoning).

Superstructure Condition Rating = 9 8 7 6 5 4 3 2 1 0

The superstructure is in good condition. Light spall (minor) occurs only on several
random segments. Spall is determined to be light and it occurs within the 13 mm
(½”) wearing surface only.

Element Level Inspection Method:

- Determine the CoRe Elements name and number.
- Calculate total quantities.
- Determine correct condition states.

Use the current (or Agency CoRe Element Guide if supplied) AASHTO CoRe Element Guide.

Area provided for notes or calculations:

| Element | Total Quantity | Unit | Quantities in Condition States | | | | |
|---|---|---------------------------------|--------------------------------|---|---|---|---|
| | | | 1 | 2 | 3 | 4 | 5 |
| CoRe Elements | | | | | | | |
| 104 Prestressed Closed Web/Box Girder | 305 (1000) | m (LF) | 182 (600) | 123 (400) | | | |
| 22 Concrete Deck Protected with Rigid Overlay | 1 (3,438 m ²) (37,000 SF) | EA (m ²) (SF) | | 1 (3,438 m ²) (37,000 SF) | | | |

| | | | | | | | |
|-----------------------|--|--|--|--|--|--|--|
| <i>Other Elements</i> | | | | | | | |
| | | | | | | | |

| | | | | | | | |
|--------------------|--|--|--|--|--|--|--|
| <i>Smart Flags</i> | | | | | | | |
| | | | | | | | |

Topic 7.12 – Concrete Box Culverts

Culvert documentation exercise (notes and sketch)

Total Quantity

Culvert Length: 13.5 m x 1 barrel = 13.5 m

45' x 1 barrel = 45'

Inspection notes:

Cracking with efflorescence on left portion of wingwall. Roadway above with cracking and patched areas. Top of culvert with heavy efflorescence, significant cracking and large spall. 2 mm (1/16") wide transverse cracks on walls on top slab and walls of culvert typical throughout length.

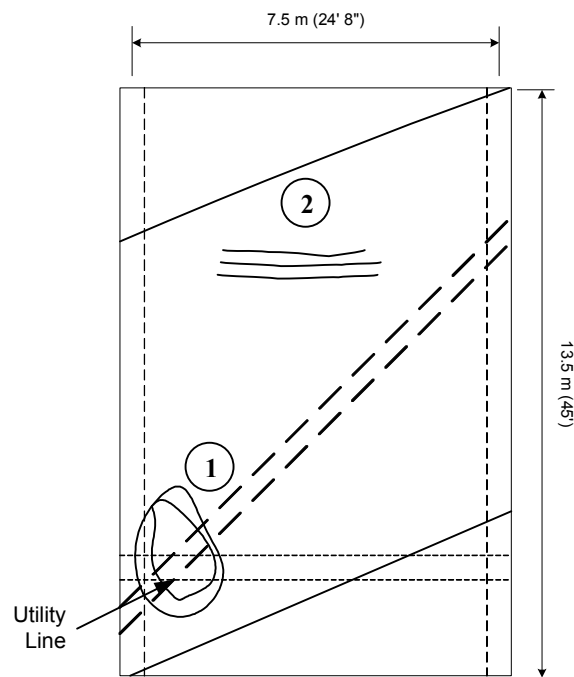
Check List

- ✓ Member Description
- ✓ Defect Locations
- ✓ Defect Description /Severity
- ✓ Defect Dimensions
- ✓ Defect Quantity (if required)

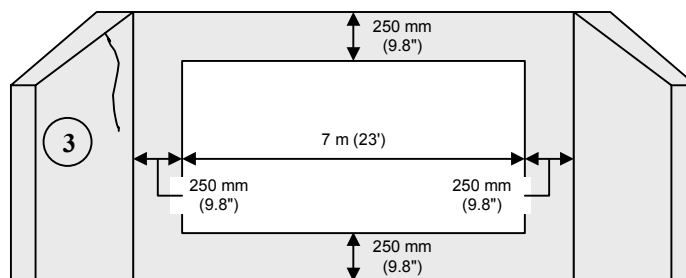
1 Large spall, 1 m (3') in diameter, above utility line (see photo 3)

2 Cracking, efflorescence typical throughout (see photo 4)

3 Cracking with efflorescence on left portion of wingwall (see photo 1)



Plan View



Elevation View

Member Concrete Culvert

Rating Exercise

Use the photos, field conditions, and dimensions given on pages 7.12.9 – 7.12.10. Rate the subject concrete box culvert.

NBI Component Rating Method:

Circle the rating for the culvert and explain why this rating was chosen (rating reasoning).

Culvert Condition Rating = 9 8 7 6 5 4 3 2 1 0

There are no alignment problems or settlement to speak of. The rating then will be determined by the condition of the concrete. The concrete has efflorescence, spalls, and cracks. The spalls are isolated but the efflorescence and cracks are significant and are widespread.

Since the cracking and efflorescence is extensive, the best rating for this culvert is a “5”.

Area provided for notes or calculations:

| Element | Total Quantity | Unit | Quantities in Condition States | | | | |
|----------------------|----------------|--------|--------------------------------|---|-----------|---|---|
| | | | 1 | 2 | 3 | 4 | 5 |
| 241 Concrete Culvert | CoRe Elements | | | | | | |
| | 13.5 (45) | m (LF) | | | 13.5 (45) | | |
| | | | | | | | |
| | | | | | | | |
| Other Elements | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| Smart Flags | | | | | | | |
| | | | | | | | |

Topic 8.2 – Steel Multi-Beams/Girders

Superstructure documentation exercise (notes and sketch)

Total Quantity

Total beam quantity =

7 beams x 9.45m L = 66.15 m say 66 m

7 beams x 31' L = 217 LF

Inspection notes:

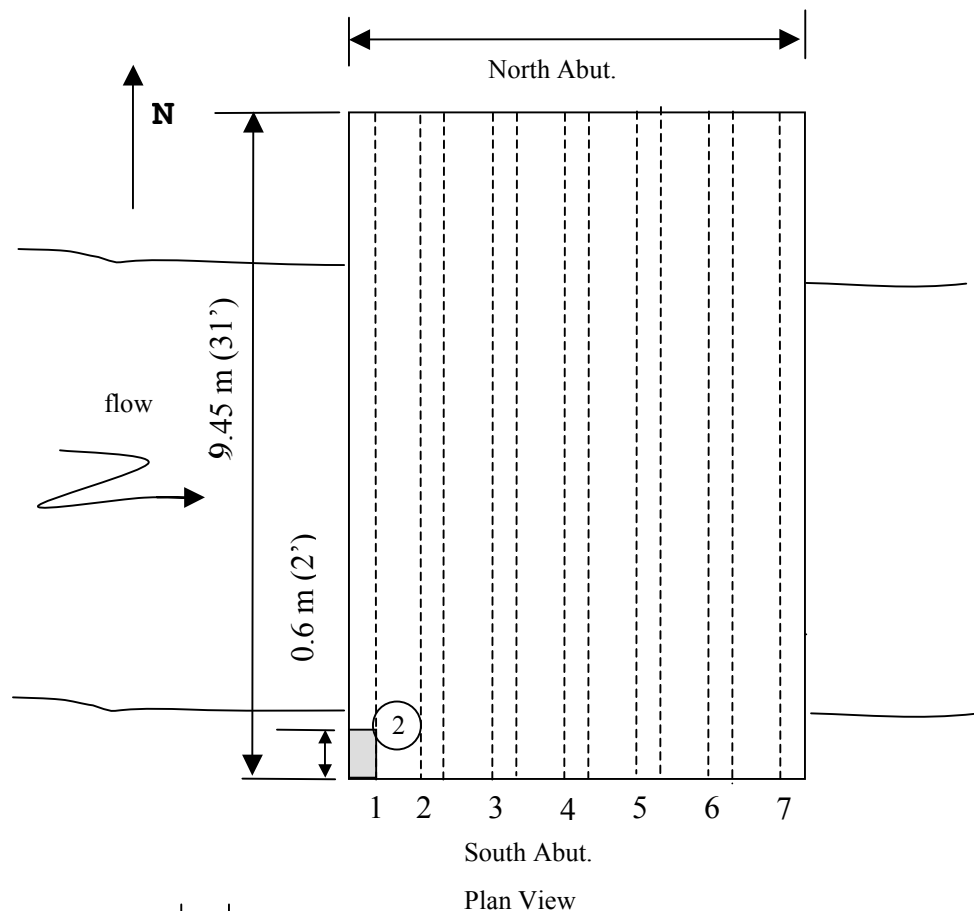
Rolled steel beams with typical random pitting throughout the beams. The max. depth of pitting is 1/16" (2 mm). Typical surface rust along top flange of beams 2 mm. (1/16") section loss to top flange of beam #1 for 0.6 m (2') from south abutment. Welded connection @ pile support – no cracks

Check List

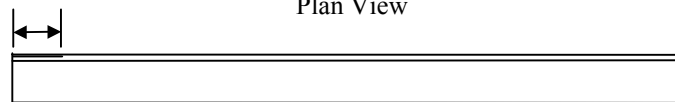
- ✓ Member Description
- ✓ Defect Locations
- ✓ Defect Description /Severity
- ✓ Defect Dimensions
- ✓ Defect Quantity (if required)

① Typical random pitting up to 2 mm (1/16") typical throughout beams. (see Photo 4).

② 2 mm (1/16") section loss to top flange of beam for 0.6 m (2') length. (see Photo 3).



Beam 1



Member STEEL GIRDER

Rating Exercise

Use the photos, field conditions, and dimensions given on pages 8.2.15 – 8.2.16. Rate the subject steel beam superstructure.

NBI Component Rating Method:

Circle the rating for this superstructure and explain why this rating was chosen (rating reasoning).

Superstructure Condition Rating = 9 8 7 6 **5** 4 3 2 1 0

Superstructure is in “fair” condition structurally. The beams which are the primary structural members, are generally sound with minor section loss. The pitting is random.

Area provided for notes or calculations:

| Element | Total Quantity | Unit | Quantities in Condition States | | | | |
|-------------------------------|----------------|-----------|--------------------------------|---|---|-------------|---|
| | | | 1 | 2 | 3 | 4 | 5 |
| 107 Painted Steel Open Girder | CoRe Elements | | | | | | |
| | 66 (217) | M (LF) | | | | 66 (217) | |
| | | | | | | | |

| | | | | | | | |
|-----------------------|--|--|--|--|--|--|--|
| <i>Other Elements</i> | | | | | | | |
| | | | | | | | |


| | | | | | | | |
|--------------------|---|----|--|---|--|--|--|
| <i>Smart Flags</i> | | | | | | | |
| 363 Section Loss | 1 | EA | | 1 | | | |

Topic 8.3 – Steel Two-Girder System

Superstructure Documentation Exercise (sketch)

Framing plan

② Floorbeam Web Crack Table

| | FB# | G# | Crack Size | Year |
|-------|-----|----|---------------|--|
| FB25 | 3 | 1 | 1/2 | 2002  |
| FB24 | 3 | 2 | 1/2 | |
| FB23 | 6 | 1 | 3/4 | |
| | 7 | 1 | 1/4 | |
| FB22 | 7 | 2 | 1 | |
| | 9 | 1 | 1 | |
| FB21 | 9 | 2 | 1/2 | |
| | 11 | 1 | 1/2 | |
| FB20 | 11 | 2 | 11/16 | |
| -FB19 | 12 | 1 | 5/8 | |
| -FB18 | 12 | 2 | 1/2 | |
| | 13 | 1 | 1/2 | |
| FB17 | 13 | 2 | 3/8 | |
| | 14 | 2 | 3/4 | |
| FB16 | 16 | 1 | 11/16 | |
| | 17 | 1 | 13/16 | |
| FB15 | 18 | 1 | 3/4 | |
| | 18 | 2 | 3/8 | |
| -FB13 | 20 | 2 | 1 3/4 | |
| -FB12 | 21 | 2 | 13/16 | |
| | 23 | 1 | 1 | |
| FB11 | | | | |

Check List

✓ Member
Description

✓ Defect Locations

✓ Defect
Description
/Severity

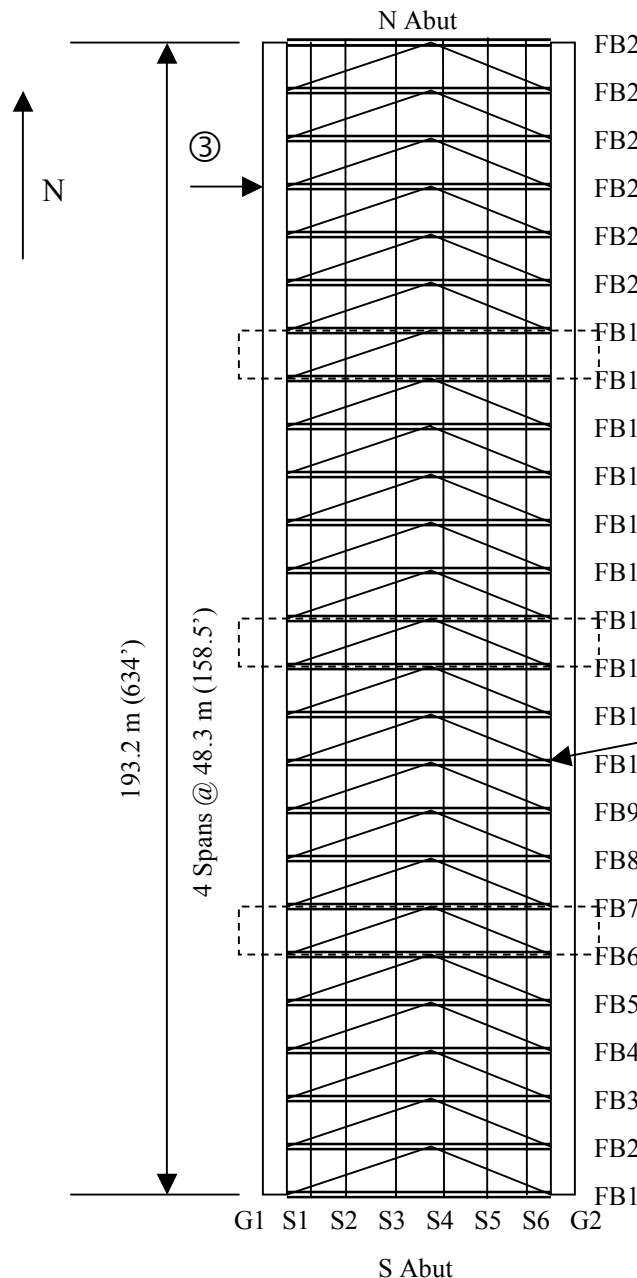
✓ Defect
Dimensions

✓ Defect Quantity
(if required)

① 19 mm (3/4") vertical crack in web stiffener weld of girder #2 @ north elevation of FB#10
(see Photo 3)

② Floorbeam web cracks
(see Photos 4-7)

③ 4 missing welds @ longitudinal web stiffener on west elevation of girder #1, span 4
(see Photo 8)



Member Open Steel Girder

Rating Exercise

Use the photos, field conditions, and dimensions given on pages 8.3.16 – 8.3.19. Rate the subject steel two-girder superstructure.

NBI Component Rating Method:

Circle the rating for this superstructure and explain why this rating was chosen (rating reasoning).

Superstructure Condition Rating = 9 8 7 6 5 4 3 2 1 0

Superstructure is in “poor” condition structurally. The floorbeams are
primary structural members and are typically found to have fatigue cracks
due to poor detail at critical locations.

Area provided for notes or calculations:

| Element | Total Quantity | Unit | Quantities in Condition States | | | | |
|-------------------------------|----------------|-----------|--------------------------------|---|---|---|---|
| | | | 1 | 2 | 3 | 4 | 5 |
| CoRe Elements | | | | | | | |
| 107 Painted Steel Open Girder | 386 (1268) | m (LF) | 386 (1268) | | | | |
| 113 Painted Stringers | 1159 (3804) | m (LF) | 1159 (3804) | | | | |
| 152 Painted Floor Beams | 259 (850) | m (LF) | 259 (850) | | | | |

| | | | | | | | |
|--------------------|---|----|--|--|---|--|--|
| <i>Smart Flags</i> | | | | | | | |
| 356 Steel Fatigue | 1 | EA | | | 1 | | |

Topic 8.4 – Pin and Hanger Assemblies

Rating Exercise

- Determine the CoRe elements name and number
- Calculate total quantities
- Determine correct condition states

Element Level Method:

Use the current AASHTO CoRe Element Guide. (Use agency core element guide if supplied)

Use the photo, and field conditions given below to determine the condition state rating of the pin and hanger assembly.



Photo 1: Close up of bottom pin and pin cap in a painted pin and hanger assembly. The top pin is in similar condition. There is corrosion with minor section loss around the pin cap and on the hanger in various locations. The superstructure consists of two deck girders. This condition is typical for both pin & hanger assemblies.

Area provided for notes or calculations:

| Element | Total | Unit | Quantities in Condition States | | | | |
|--|---------------|------|--------------------------------|---|---|---|---|
| | Quantity | | 1 | 2 | 3 | 4 | 5 |
| 161 Pin and Hanger Assembly Painted (Pg. 25) | CoRe Elements | | | | | | |
| | 2 | EA | | | | 2 | |
| | | | | | | | |

| | | | | | | | |
|------------------------------|--------------------|----|--|---|--|--|--|
| 363 Section Loss (Pg. 49) | <i>Smart Flags</i> | | | | | | |
| | 1 | EA | | 1 | | | |

Topic 8.5 – Steel Box Girders

Superstructure documentation

Total Quantity:

**Closed Box Girder = 2 EA x 222.5 m L = 445 m or
2 EA x 730' L = 1460 LF**

Check List

✓ Member
Description

✓ Defect Locations

✓ Defect Description
/Severity

✓ Defect Dimensions

✓ Defect Quantity (if
required)

**Open Girder (Outriggers) = 74 EA x 6.1 m L x 2 faces = 902 m
74 EA x 20' L x 2 faces = 2960 LF**

Exp. Bearings = 4 locations X 2 EA = 8 EA

Fixed Bearings = 1 location x 2 EA = 2 EA

Steel Fatigue = 1 crack location = 1 EA

Inspection notes:

Failure of paint system on insides of boxes w/ surface rust along top of bottom flange plate. A 184 mm (7 1/4") horizontal fatigue crack was found in longitudinal web stiffener weld located in span 4, Box 2, inside east web between diaphragms 1 & 2. Fire damage w/ heavy debris in Span 2, Box 2, Bays 6, 7 & 8. Cantilevered outriggers in good condition. Bearings in good condition.

① Typical failure of paint system on inside of boxes with surface rust on top of bottom flange.

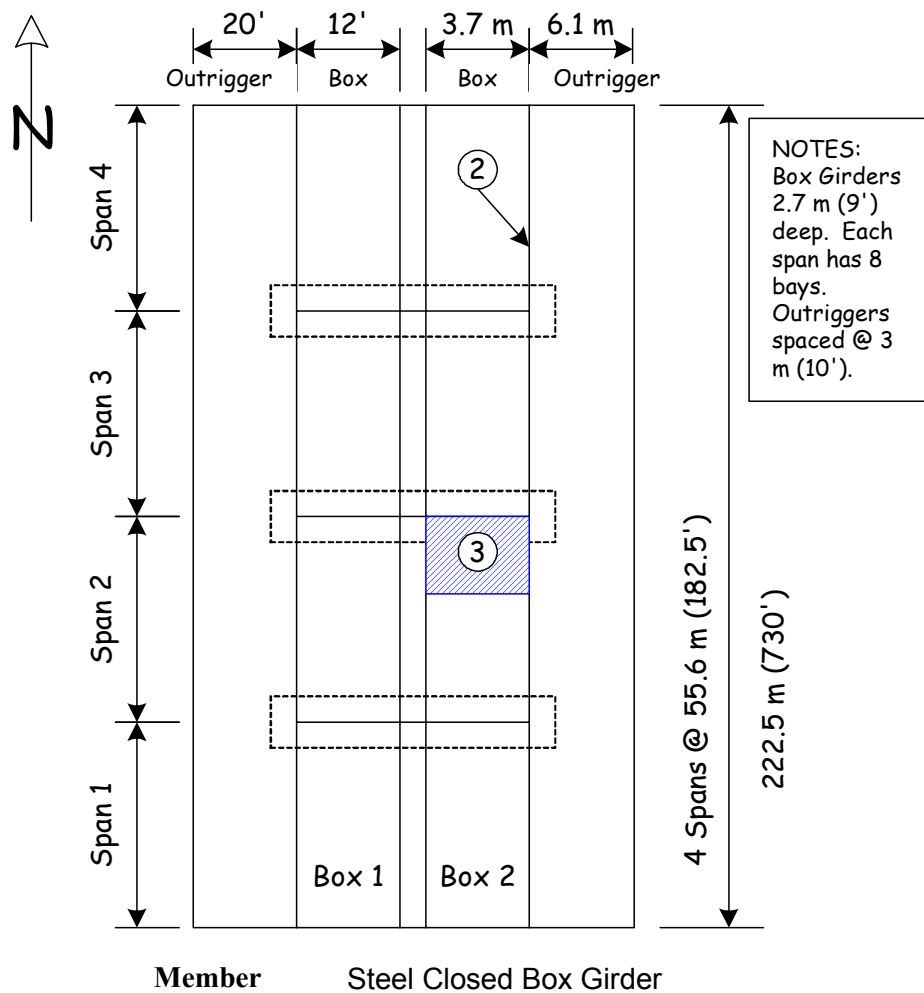
(see Photos 3 & 4)

② 184 mm (7 1/4") crack Span 4, Box 2, east web.

(see Photo 5)

③ Fire damage Span 2, Box 2, Bays 6, 7, and 8.

(see Photos 6 & 7)



Practice Unit

Rating Exercise

Use the photos, field conditions, and dimensions given on pages 8.5.13 – 8.5.15. Rate the subject steel beam superstructure.

NBI Component Rating Method:

Circle the rating for this superstructure and explain why this rating was chosen (rating reasoning).

Superstructure Condition Rating = 9 8 7 **6** 5 4 3 2 1 0

Superstructure is in “fair” condition structurally. All structural elements are sound but have minor deterioration. There is a 184 mm (7 ¼”) crack in longitudinal stiffener weld in compression area. Fire damage did not appear to cause any structural damage to the bottom flange or webs (deck damage is rated separately). There is paint peeling with surface rust. 10% of remaining steel exhibits pitting.

Area provided for notes or calculations:

| Element | Total Quantity | Unit | Quantities in Condition States | | | | |
|---|----------------|--------|--------------------------------|---|------------|---|---|
| | | | 1 | 2 | 3 | 4 | 5 |
| CoRe Elements | | | | | | | |
| 102 Painted Steel Closed Web Box Girder | 445 (1460) | m (LF) | | | 445 (1460) | | |
| 107 Painted Steel Open Girder | 902 (2960) | m (LF) | 902 (2960) | | | | |

| | | | | | | | |
|--------------------|---|----|--|---|--|--|--|
| <i>Smart Flags</i> | | | | | | | |
| 356 Steel Fatigue | 1 | EA | | 1 | | | |

Topic 8.6 – Steel Trusses

Superstructure documentation exercise (notes and sketch)

Total Quantity

**Truss = 2 EA x 34.5 m L = 69 m or
(2 EA x 113' L = 226 LF)**

**Stringers = 5 EA x 34.5 m L = 172.5 m say 172 m
(5 EA x 113' L = 565 LF)**

**Floorbeams = 9 EA x 8.2 m L = 73.8 m say 74 m or
(9 EA x 27' L = 243 LF)**

Inspection notes:

Check List

✓ Member
Description

✓ Defect Locations

✓ Defect
Description
/Severity

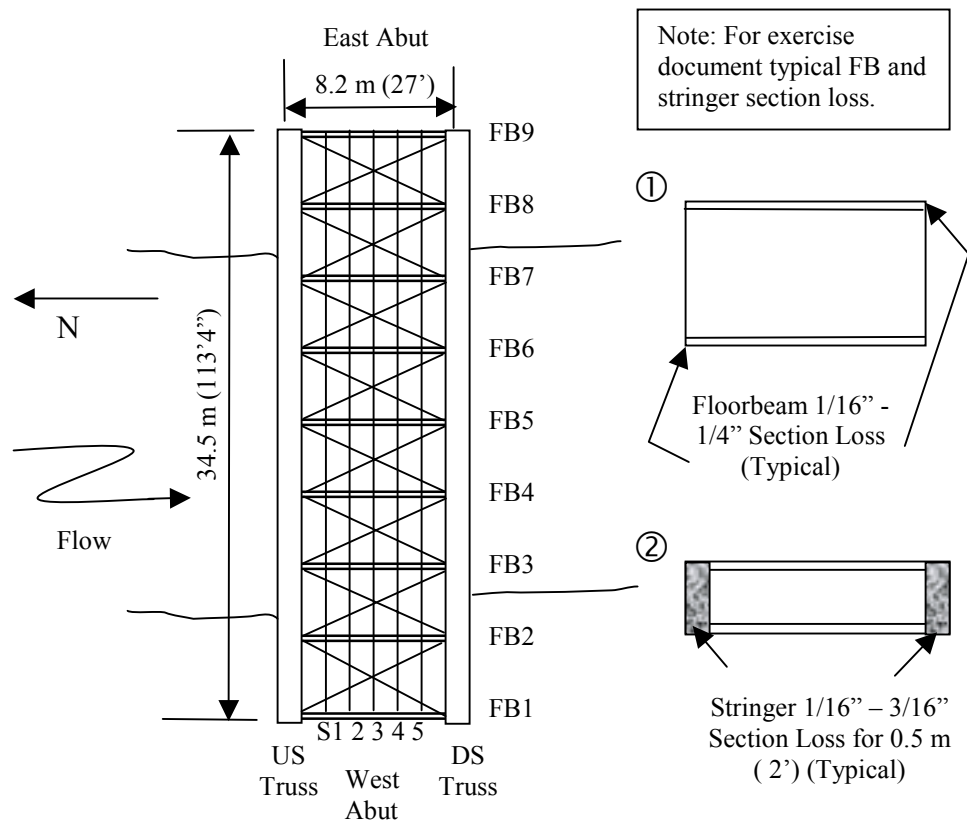
✓ Defect
Dimensions

✓ Defect Quantity
(if required)

① Floorbeams have
1/16" – 1/4" section
loss on top & bottom
flanges typical.
(see Photos 6B – 12)

② Stringers have
1/16" – 3/16" section
loss on web & flanges
for 2' from connection
to FB typical.
(see Photos 6B – 12)

Both trusses in generally satisfactory condition. All FB's have 2 mm (1/16") to 6 mm (1/4") section loss along top & bottom flanges typical. All stringers have 2 mm (1/16") to 5 mm (3/16") section loss on top & bottom flanges & web for 2 LF from FB connections see sketch.



Member Painted Steel Truss

Rating Exercise

Use the photos, field conditions, and dimensions given on pages 8.6.25 – 8.6.28. Rate the subject steel truss superstructure.

NBI Component Rating Method:

Circle the rating for this superstructure and explain why this rating was chosen (rating reasoning).

Superstructure Condition Rating = 9 8 7 6 5 **4** 3 2 1 0

SUPERSTRUCTURE IS IN "POOR" CONDITION STRUCTURALLY. THE PRIMARY STRUCTURAL
MEMBERS (FLOOR SYSTEM) HAVE SIGNIFICANT AND WIDE SPREAD SECTION LOSS.
STRUCTURAL CAPACITY OF THE FLOOR SYSTEM IS ASSUMED TO BE ADVERSELY AFFECTED.

Area provided for notes or calculations:

(Metric) Stringers (8 sets) (5 stringers/set) (0.5 m /end) (2ends) = 40 m

(English) Stringers (8 sets) (5 stringers/set) (2' /end) (2ends) = 160'

| Element | Total Quantity | Unit | Quantities in Condition States | | | | |
|--|----------------|-----------|--------------------------------|---|---|---|-------------|
| | | | 1 | 2 | 3 | 4 | 5 |
| CoRe Elements | | | | | | | |
| 126 Through Truss Excluding Bottom Chord | 69 (226) | m (LF) | 69 (226) | | | | |
| 121 Through Truss Bottom Chord | 69 (226) | m (LF) | 69 (226) | | | | |
| 113 Painted Stringers | 172 (565) | m (LF) | 132 (405) | | | | 40 (160) |
| 152 Painted Floor Beams | 74 (243) | m (LF) | | | | | 74 (243) |

| | | | | | | | |
|--------------------|---|----|--|--|---|--|--|
| <i>Smart Flags</i> | | | | | | | |
| 363 Section Loss | 1 | EA | | | 1 | | |

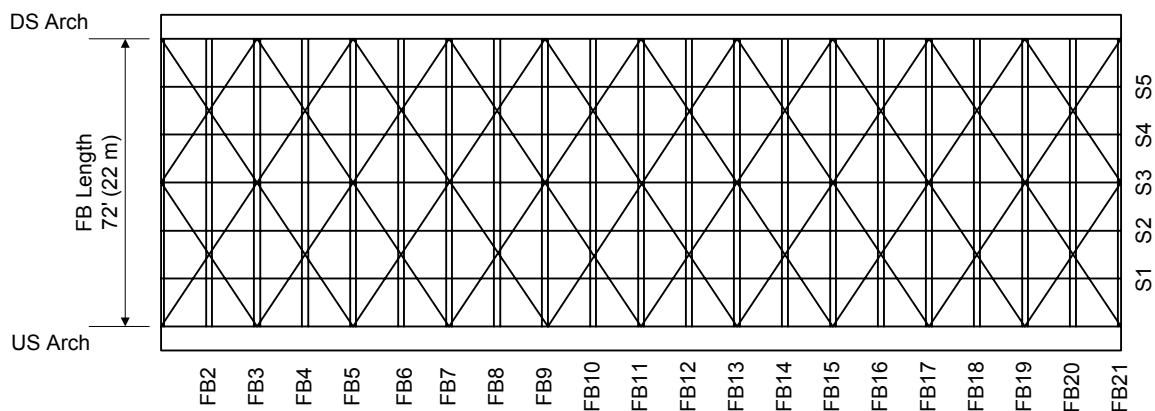
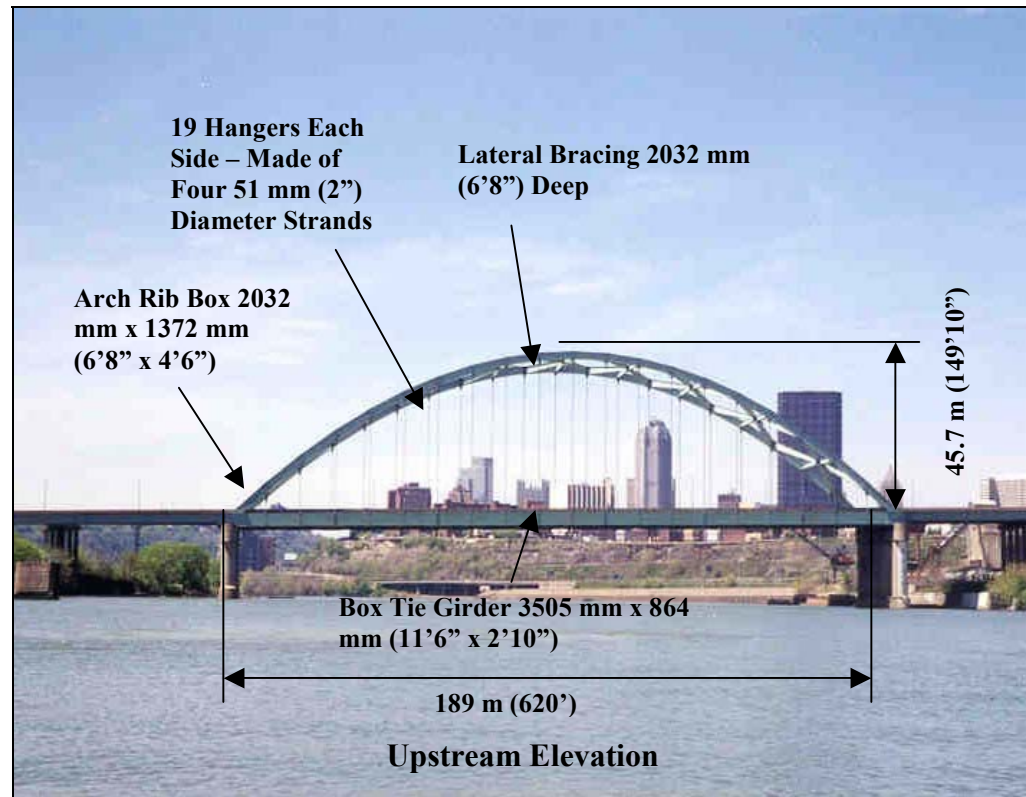
Topic 8.8 – Steel Arches

Superstructure documentation exercise (notes and sketch)

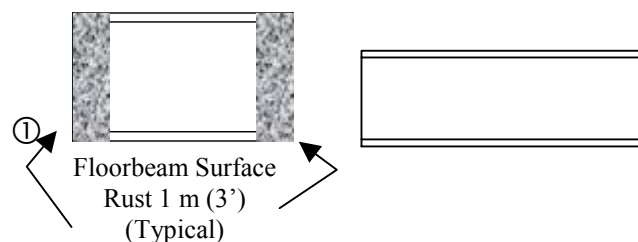
The superstructure of the arch span consists of solid ribbed box members. The floorbeams are fabricated girders, which are approximately 2438 mm (8') deep and spaced at 9449 mm (31'). The stringers are 533 mm (21") deep rolled wide flange beams. Top lateral bracing is fabricated I-girders.

Check List

- ✓ Member Description
- ✓ Defect Locations
- ✓ Defect Description /Severity
- ✓ Defect Dimensions
- ✓ Defect Quantity (if required)



- ① Minor surface rust at FB connection to tie box girder typical. (see Photo 2)



Note: For exercise document typical FB and stringer section loss.

Superstructure documentation exercise (notes and sketch)

Total Quantity

Arch = 2 EA x 189 m L = 378 m or**2 EA x 620' L = 1240 LF****Closed Box Girder = 2 EA x 189 m = 378 m or****2 EA x 620' L = 1240 LF****Cable = 19 Hangers x 2 sides = 38 x 4 Cables
= 152 EA****Stringers = 5 EA x 189 m L = 945 m or****5 EA x 620' L = 3100 LF****Floorbeams = 21 EA x 22 m L = 462 m or****21 EA x 72' L = 1512 LF**

Inspection notes:

Check List√ Member
Description√ Defect Locations√ Defect
Description
/Severity√ Defect
Dimensions√ Defect Quantity
(if required)

No defects were found in both arch rib members. Box tie girders typically in good condition with minor surface rusting throughout. Stringers generally in good condition. The upper and lower hanger connections appear to be in good condition, as do the cables themselves. The floorbeams typically show minor surface rusting at the box tie girder connections. Numerous cracks were found in FB web-to-top flange welds near box tie girder connection of both arches. 77 cracks total; 5 cracks propagated into FB base metal. Crack lengths vary from 13 – 146 mm ($\frac{1}{2}$ " – $5\frac{3}{4}$ ").

② Minor surface rusting typical inside box girders.
(see Photo 3)

③ 77 cracks at FB top flange-to-web weld near the box tie girder connection of both arches.
(see Photo 4)

Topic 8.8 – Steel Arches (continued)**Rating Exercise**

Use the photos, field conditions, and dimensions given on pages 8.8.20 – 8.8.22. Rate the subject steel tied arch superstructure.

NBI Component Rating Method:

Circle the rating for this superstructure and explain why this rating was chosen (rating reasoning).

Superstructure Condition Rating = 9 8 7 6 5 4 3 2 1 0

Superstructure is in “fair” condition structurally. The primary structural elements are sound, but have out-of-plane distortion cracks caused by the longitudinal movement of the floor system. There are 77 such crack locations in FB top flange-to-web welds.

Area provided for notes or calculations:

Floorbeams – Surface Rust CoRe 152

1 m x (2 ends/FB x 21 FB) = 42 m CS 3

3' x (2 ends/FB x 21 FB) = 126' CS 3

462 – 42 = 420 m CS 1

1512 – 126 = 1386' CS 1

| Element | Total Quantity | Unit | Quantities in Condition States | | | | |
|---|----------------|-----------|--------------------------------|---|---------------|---|---|
| | | | 1 | 2 | 3 | 4 | 5 |
| Painted Steel | CoRe Elements | | | | | | |
| 102 Closed Web/Box Girder | 378 (1240) | m (LF) | | | 378 (1240) | | |
| 113 Stringer | 945 (3100) | m (LF) | 945 (3100) | | | | |
| 141 Arch | 378 (1240) | m (LF) | 378 (1240) | | | | |
| 152 Floorbeam | 462 (1512) | m (LF) | 420 (1386) | | 42 (126) | | |
| 146 Uncoated Cable (not in concrete) | 152 | EA | 152 | | | | |

| | | | | | | | |
|--------------------|---|----|--|--|---|--|--|
| <i>Smart Flags</i> | | | | | | | |
| 356 Steel Fatigue | 1 | EA | | | 1 | | |

Topic 9.1 – Bridge Bearings

Area provided for notes or calculations:

| Element | Total Quantity | Unit | Quantities in Condition States | | | | |
|-------------------------|-------------------|------|--------------------------------|---|---|---|--|
| | 1 | | 2 | 3 | 4 | 5 | |
| 311 Moveable Bearing | Core Elements | | | | | | |
| | 2 | EA | | 2 | | | |
| 313 Fixed Bearing | 2 | EA | 2 | | | | |

| | | | | | | | |
|--|-----------------------|--|--|--|--|--|--|
| | <i>Other Elements</i> | | | | | | |
| | | | | | | | |
| | | | | | | | |

| | | | | | | | |
|--|--------------------|--|--|--|--|--|--|
| | <i>Smart Flags</i> | | | | | | |
| | | | | | | | |
| | | | | | | | |

Topic 10.1 – Abutments**Substructure documentation exercise (notes and sketch)**

Total Quantity

Total abutment quantity = 2 abuts x 18 m L = 36 m
2 abuts x 60' L = 120 LF

Inspection notes:

North abutment has full ht vert crack 2 – 3 mm (1/16" – 1/8") wide w/ water leakage, delam & efflo. 1st exp jt has opened 89 mm (3 1/2") @ top this is 12 mm (1/2" more than last insp. South abut has cracked, delam bearing seat w/ water leakage & rust stains. S. abut has full ht vert crack 2 mm (1/16") wide w/ delam, efflo & rust stains.

Check List

√ Member
Description

√ Defect Locations

√ Defect
Description
/Severity

√ Defect
Dimensions

√ Defect Quantity
(if required)

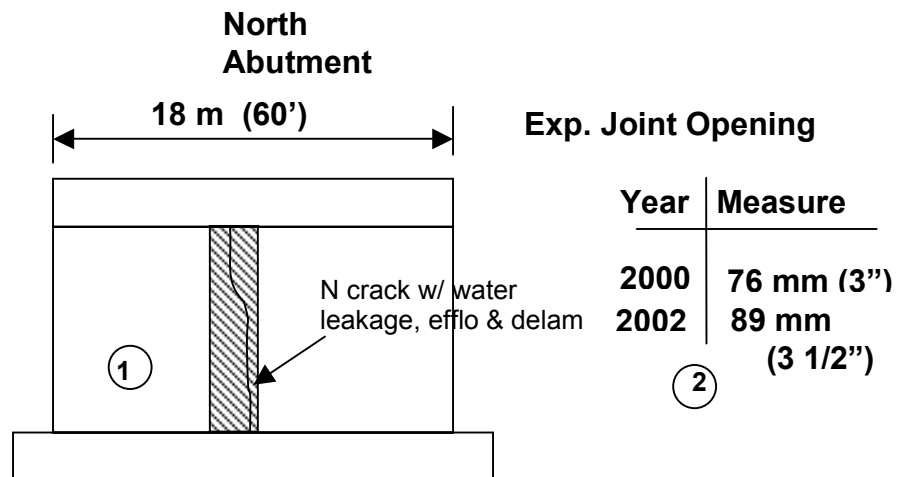
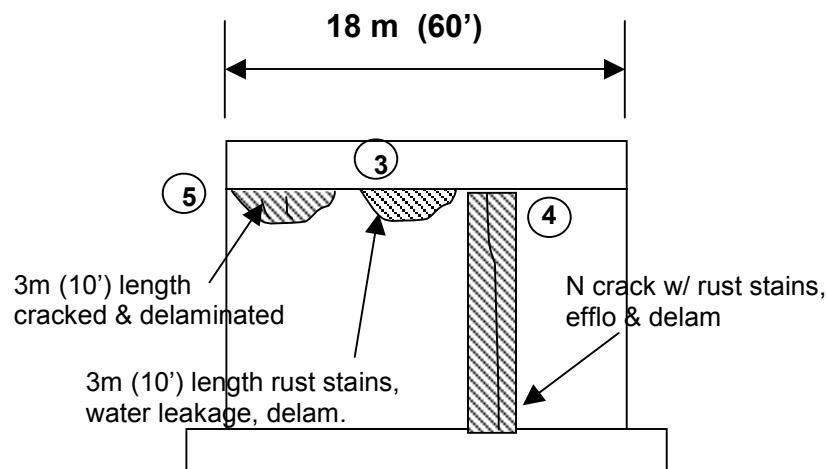
① Full height vertical crack 2 – 3 mm (1/16" – 1/8"). (see Photo 3)

② First exp. Joint from west end of north abut. (see Photo 2)

③ Bearing seat of south abut (see Photo 6)

④ South abut. 2 mm (1/16") crack. (see Photo 7)

⑤ Bearing seat of south abut east corner (see Photo 8)

**South Abutment**

Rating Exercise

Use the photos, field conditions, and dimensions given on pages 10.3.2 – 10.3.4. Rate the subject reinforced concrete substructure.

NBI Component Rating Method:

Circle the rating for this substructure and explain why this rating was chosen (rating reasoning).

Substructure Condition Rating = 9 8 7 6 **5** 4 3 2 1 0

Substructure is in “fair” condition structurally. There is minor deterioration, cracking, and spalling of the concrete that requires documentation. Bearing areas are somewhat affected by the deterioration, but the primary elements (abutments) are still sound.

Area provided for notes or calculations:

Cracked & delaminated bearing areas of south abutment:
2 areas X 3 m (10') each = 6 m (20') in CS 3

Full ht vertical cracks 2 – 3 mm (1/16" – 1/8") with efflorescence & delamination, one (1) at each abutment:
Assume a 0.5 m (1') wide area x 2 cracks = 1 m (2') CS 2

Remainder of abutment length goes into CS 1:
36 m (120') – 6 m (20') – 1 m (2') = 29 m (98')

| Element | Total Quantity | Unit | Quantities in Condition States | | | | |
|---------------|----------------|-----------|--------------------------------|----------|-----------|---|---|
| | | | 1 | 2 | 3 | 4 | 5 |
| CoRe Elements | | | | | | | |
| 215 Abutment | 36 (120) | m (LF) | 29 (98) | 1 (2) | 6 (20) | | |
| | | | | | | | |

| | | | | | | | |
|-----------------------|--|--|--|--|--|--|--|
| <i>Other Elements</i> | | | | | | | |
| | | | | | | | |

| | | | | | | | |
|--------------------|---|----|--|--|---|--|--|
| <i>Smart Flags</i> | | | | | | | |
| 360 Settlement | 1 | EA | | | 1 | | |
| | | | | | | | |

Topic 10.2 – Piers and Bents

Substructure documentation exercise (notes and sketch)

Total Quantities:

Pier caps = 3 caps x 14 m L = 42 m

3 caps x 45' L = 135'

Column = 3 piers x 2 EA = 6 EA

Inspection notes:

Abuts: N. - good condition

F. - 2 mm (1/16") cracking typ.

Pier #1: Cap - delam, spalling, efflo & exp rebar

N. column - severe spalling & rebar w/ section loss

Pier #2: N. column - cracking, delam & 6 mm (1/4") full ht crack

S. column - efflo, delam & severe spalling w/ missing conc & rebar w/ loss

Pier #3: N. column - hairline cracks & repairs

Check List

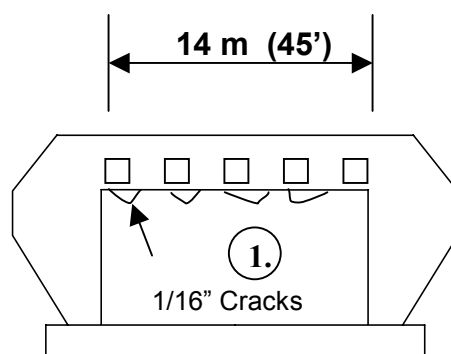
✓ Member
Description

✓ Defect Locations

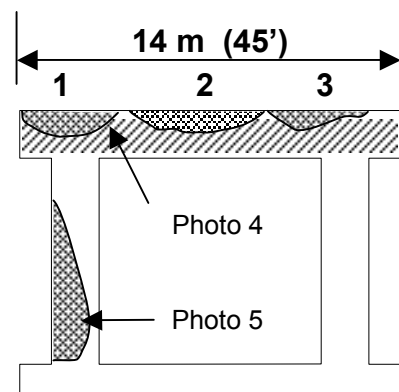
✓ Defect
Description
/Severity

✓ Defect
Dimensions

✓ Defect Quantity
(if required)



Far (east) Abutment



West Face Pier No. 1

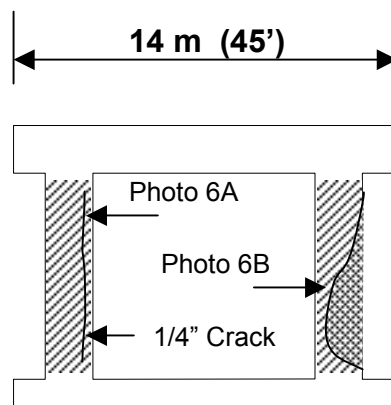
1. Typical cracking and separation of concrete (see photos 2A & B).



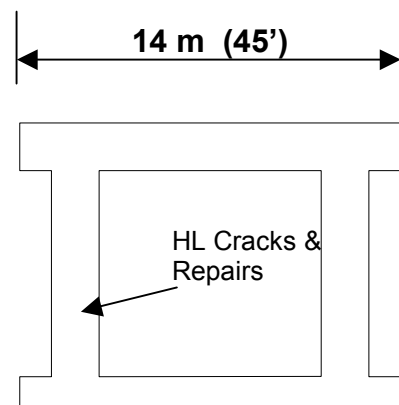
Delaminated



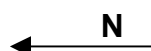
Spalled



West Face Pier No. 2



West Face Pier No. 3



Rating Exercise

Use the photos, field conditions, and dimensions given on pages 10.3.6 – 10.3.8. Rate the subject reinforced concrete substructure.

NBI Component Rating Method:

Circle the rating for this substructure and explain why this rating was chosen (rating reasoning).

Substructure Condition Rating = 9 8 7 6 5 **4** 3 2 1 0

Substructure is in “poor” condition structurally. The piers show excessive disintegration of the concrete and advanced corrosion of the reinforcing bars.

Area provided for notes and calculations:

| Pier | Column | CS |
|------|--------|----|
| 1 | North | 4 |
| | South | 1 |
| 2 | North | 2 |
| | South | 4 |
| 3 | North | 2 |
| | South | 1 |

| Element | Total Quantity | Unit | Quantities in Condition States | | | | |
|----------------------------------|-------------------|-----------|--------------------------------|---|------------|---|---|
| | | | 1 | 2 | 3 | 4 | 5 |
| 234 RC Cap 205 RC Columns | Core Elements | | | | | | |
| | 42 (135) | m (LF) | 28 (90) | | 14 (45) | | |
| | 6 | EA | 2 | 2 | | 2 | |

| | <i>Other Elements</i> | | | | | | |
|--|-----------------------|--|--|--|--|--|--|
| | | | | | | | |
| | | | | | | | |

| | <i>Smart Flags</i> | | | | | | |
|--|--------------------|--|--|--|--|--|--|
| | | | | | | | |
| | | | | | | | |

Topic 10.3 – NBI Case Studies

Substructure documentation exercise (notes and sketch)

Inspection notes:

Both north & south abutments exhibit minor HL cracks & spalling throughout. S abut blackened br seat from fire w/ no damage noted. N abut ftg completely exposed w/ no undermining & exhibits heavy abrasion. N abut has moved 3" (76 mm) longitudinally since last insp w/ no rotation noted.

Check List

√ Member
Description

√ Defect Locations

√ Defect
Description
/Severity

√ Defect
Dimensions

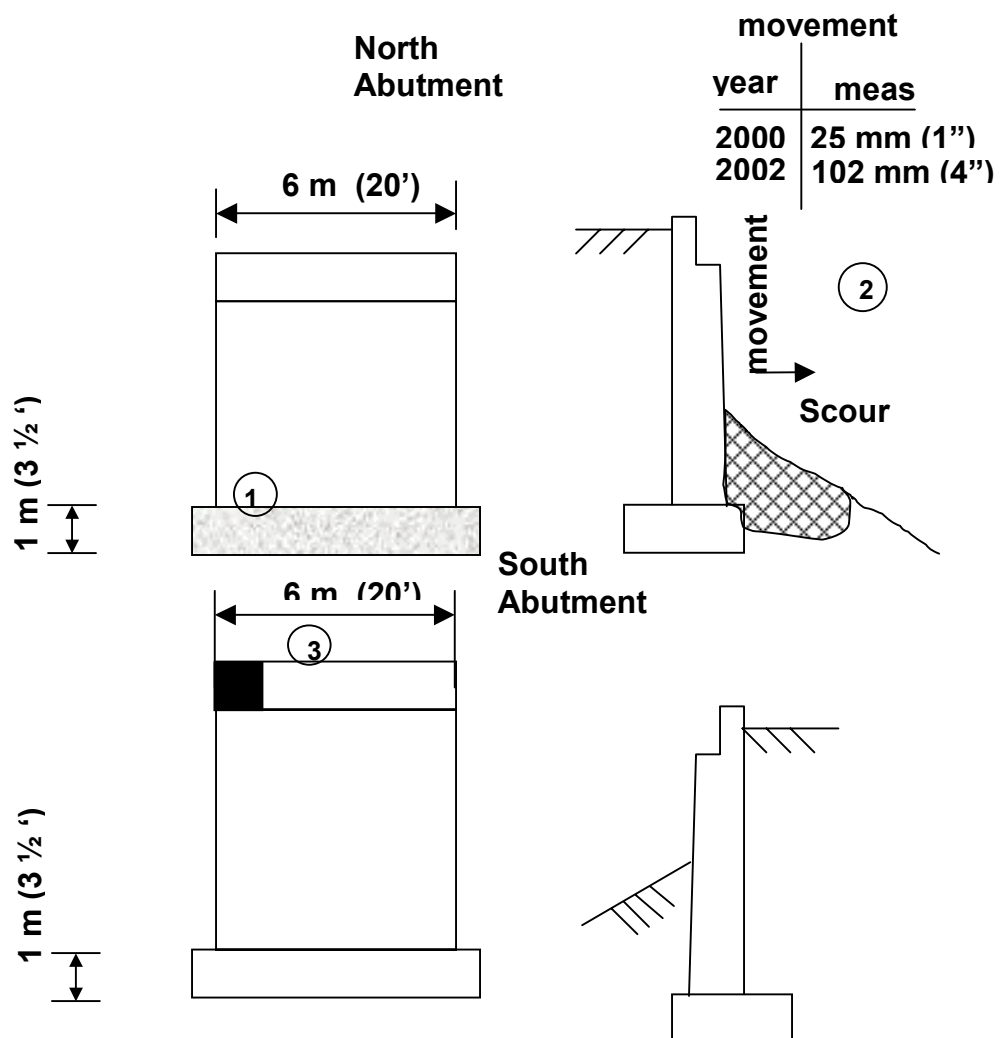
√ Defect Quantity
(if required)

① Heavy abrasion
of footing.
(see Photo 2)

② Exposed ftg w/
no undermine; 3" (76
mm) movement since
last insp.
(see Photo 3A)

③ Fire blackening
(see Photo 3B)

④ Minor spalls &
random HL cracks
typical
(see Photo 4)



Rating Exercise

Use the photos, field conditions, and dimensions given on pages 10.3.10 – 10.3.11. Rate the subject reinforced concrete substructure.

NBI Component Rating Method:

Circle the rating for this substructure and explain why this rating was chosen (rating reasoning).

Substructure Condition Rating = 9 8 7 6 5 4 **3** 2 1 0

Substructure is in “serious” condition structurally. The shifting channel and local scour have caused saturation of the clay foundation material under north abutment. This has resulted in active sliding failure evident by the abnormal tilt of the rocker bearings.

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